EPHEMERI VITA:

OR THE

Natural History

AND

ANATOMY

OF THE

EPHEMERON.

A Fly that Lives but

FIVE HOURS.

Written Originally in Low-Dutch

BY

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TO THE

READER.

THE account of ſo wonderful an Inſect (and what is there indeed in the whole Creation, if curiouſly examined, but would excite our greateſt Admiration, and force us to adore the Infinite Wiſdom of the Maker?) I doubt not but will be acceptable to the Ingenious. Our Author, the Accurate and laborious Dr. *Swammerdam*, as by his other Treatiſes ſo well received, ſo no leſs by this, hath highly deſerved of the Learned; it containing ſo many Curious and New Diſcoveries. It was Printed in Low-Dutch in *octavo*. *Anno* 1675. containing above 420 pages: what made it ſo large, was his frequent, Pious Meditations, and Poetry upon the various accidents of the Life, and extraordinary Mechaniſm of this Creature: ſo natural a guide ſuch Philoſophy is to Divinity, that the Apoſtle himſelf * tells us, τὰ γὰρ ἀόρατα αὐτοῦ ἀπὸ κτίσεως κόσμου, τοῖς ποιήμασι νοούμενα καθορᾶται, ἥτε ἀΐδιος αὐτοῦ δύναμις καὶ θειότης, εἰς τὸ εἶναι αὐτοὺς ἀναπολογήτους. "The Wiſ-

* Rom. 1. 20.

"dom of God receives ſmall honour from thoſe "vulgar heads, that rudely ſtare about, and with "a groſs Ruſticity admire His Works; Thoſe "highly Magnifie him, whoſe judicious inquiry "into his Acts, and deliberate reſearch into his "Creatures, return the Duty of a devout and "learned Admiration *.

But the Contemplations for ſome reaſons are omitted in this Tranſlation; and we here only preſent you with the Philoſophical part, the Natural Hiſtory and Anatomy of this ſtrange Fly: a Fly that in all Ages has exerciſed the Pens of the moſt Ingenious; but never any with that ſucceſs and happineſs, as our Authors.

My chief deſign in the Publication is the improvement of Natural Hiſtory; which is better written from Natures own Copy, than the faulty Tranſcripts of her many Commentators. Beſides, the moſt that hitherto we have had, is but the Shell; far greater Treaſures lye hid within; and if we would underſtand how 'tis that Nature gives Life and Motion to theſe *Automata*, we muſt unlooſe the Caſe, and take aſunder the ſeveral Wheels and Springs, and carefully obſerve how ſhe joyns them all together. Not only ‖ Phyſick, but a great part of Philoſophy will receive a vaſt improvement from ſuch an *Analyſis* of Animal bodies: And an Hiſtory of Animals can't rationally be writ without their Anatomy; unleſs we

* *Religio Medici*, p. m. 10. ‖ *See the Preliminary Diſcourſe to the Anatomy of the Perſpe.*

would

would content our ſelves in admiring their Cloathing and Paint, and ſtill remain ignorant how 'tis they live and differ from one another.

Of late ſeveral things have been done this way; enough to encourage a farther proſecution of it; and a great means to it, I think, may be, to make common, ſuch helps and aſſiſtances, as others labors and travails in it, have already furniſhed. The Anatomy of one Animal, will be a Key to open ſeveral others; and until ſuch time as we can have the whole compleated; 'tis very deſirable to have as many as we can of the moſt different, and anomalous. This curious piece being in a Language leſs known to the generality of the Learned here, a Tranſlation of it was undertaken, (tho' otherwiſe out of his way) by a perſon of my acquaintance, who had no other deſign than to gratifie the Ingenious and Curious in theſe Studies, that are unacquainted with that Language; and ſince this was his aim, 'tis hoped he may receive a favourable Cenſure, if in all things he have not ſo fully anſwered Expectation.

I doubt not but upon a ſtrict enquiry we may meet with *Ephemerons* here in *England*; if not the **Haft** of the *Dutch*, which is here deſcribed, yet ſeveral other ſorts. Our *May-fly* will well deſerve to be examined; and what is here performed, will very much facilitate the Anatomy of other Inſects too: Which if it ſhall have

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that ſucceſs as to encourage other undertakers in ſuch pleaſant and no leſs uſeful Studies, however Ignorance may deride the Curioſity, I ſhall have fully attained my aim in handing this Tranſlation to the Ingenious Reader.

Edw. Tyſon, M. D.

On the Hiſtory of the *Ephemeron.*

Although the Great Creators *Wiſdom ſhone*
Both in his Foot-ſtool, *and his* Throne,
Though greater *Bodies make the* louder *noiſe,*
Yet in the leſſer *is a* Voice,
A Voice, *though* ſtill
That doth the mind with Admiration fill,
And gives to man the Product of his will.
The Inſect-world *but lately known,*
Doth both his Skill *and* Glory *too, declare,*
They *a Creator own*
No leſs than does the Sun,
Their Riſe, their Life, their End,
Sparks of Wiſe pow'r *comprehend.*
Nay, if we Great *with* Small *compare,*
We find theſe Little-Heraulds *too, Proclaim*
Jehovah's *Mighty Name,*
They tell his praiſe,
And Trophies to his Wiſdom raiſe,
That does in Little *much expreſs,*
Like the beſt Limners *art, that moſt affects the leſs.*
The ſmalleſt Ant *does* Providence *Teach,*
Does Foreſight *to the Sluggard Preach,*
And here in this Ephemeron *we ſee*
An Emblome both of Change, *and of* Mortality.
How ſtrong muſt be the Plaſtick force
That the ſmall Eggs *contain?*
That Water makes not worſe,
A Body fluid, cold;
Nay hatches 'em at laſt,
As well as gentle heat of Hen, *or* Sun,
A thing ſo ſtrange, ſo bold,
As ſcarce perhaps no Author *ever told,*
Or heretofore was done:
Truth in new moulds is caſt,

And

And Future Age *may more unfold,*
What from the Former *we expect in vain,*
This Treasure, where's enough, we from the Deep *regain.*
What instinct has the Worm *to bore a* Cell
Wherein he may securely dwell?
Whose hard fare, joyn'd with Ease, and Sloth,
Perhaps does something to retard his growth.
Though meat *be dry, yet* drink *there is good store,*
Tipple still streaming by his door,
Like other Natives *both begot and bred,*
Where Thetis *shews her Briny head,*
And Neptune *swaggers o'r the dead.*
Well may both Worm *and* Man *that Element desire,*
Both moistening *so require,*
Which is so natural nought can be more,
Congenial to their first beginning
As to a Spider *is her Spinning,*
And is a means to both of getting higher.
After a long Subaqueous *abode,*
The Watry Native longs to range abroad,
Shoots through his liquor, and no sooner spyes
The Stranger Element, *the Skies,*
The Poets Metamorphosis
Was not more strange, more quick than this,
Unstrips, his burthen leaves, and then more nimbly Flies.
How many parts the Inside *does contain?*
All here made plain
And obvious to the mean'st Capacity,
What parts the Worm, *and* Fly,
What makes the Change *of Name,*
What parts are alter'd, what the same,
Into all which he that desires to pry,
Needs now no Microscope, *but sees with half an eye.*

T. GUIDOTT.

EPHE-

EPHEMERI VITA:

OR THE

Natural Hiſtory

AND

ANATOMY

OF THE

EPHEMERON,

A Fly that lives but Five Hours.

CHAP. I.

That the Ephemeron *is Produced out of an Egg.*

AS all Vegetables proceed from a known Fructifying Seed; ſo is alſo the Production of all Animals and Inſects, *viz.* out of a Seed or Egg: So that nothing we diſcern to have life, but it proceeds from an Egg, Man as well as all other Creatures. And notwithſtanding the Common Opinion that many Inſects named Exanguious, are chance-births, taking their original from Corruption, that is, out of the motion of the moiſture and warmth which proceedeth from Corrupting matter, either in Inanimate or Senſitive Bodies, or Vegetables; conſtant experience teacheth us the contrary, as, among other, appeareth in this account of the Production of the *Ephemeron*, which proceedeth from a Viſible and

known Seed, contrary to that falſe opinion of men prejudiced to the contrary, who believe they are Produced out of putrifying Clay and Water; as if ſuch a *chance-Productor* had the power to produce a Creature in all Ages to be admired, and hardly by the moſt Ingenious and Wiſe to be deſcribed.

This (*a*) *Ephemeron* is a Four-winged creature, furniſhed with Two ſmall Horns, Six Legs, Two very long and ſtraight hairy Tails, and living at longeſt in this ſhape or form but Five Hours; is found yearly in all the mouths or entrances of the *Rhine*, as the *Maes*, the *Wael*, the *Leck*, and the *Iſel*; about Midſummer flying on the Surface of the water for Three dayes ſucceeding; but with this difference, that thoſe which have lived and flown the Firſt day, die the ſame Evening; and the ſame happens the Second and Third day, and then ceaſeth till next Year and Seaſon when the like happens again. (*a*) Tab. 8. Fig. 1.

At the ſame time the (*b*) Female *Ephemeron* being riſen out of the water, and in the riſing, having ſhed her Skin, and having for ſome time flown, and as it were ſported above the Surface of the water, ſhe ſhooteth her double (*c*) Egg cluſter, or Ovarium in the water; after which the (*d*) Male alſo being riſen out of the water, and as before in the riſing having ſhed his skin, and afterwards on Land ſtript another (*e*) thin Film, alſo ſhooteth his Seed on the Female Seed, and thereby fructifieth it. But how properly this Generation is effected, and how theſe Inſects riſe out of the water, and how in the water and on the land they ſhed their Skins, ſhall be in this following relation more largely and circumſtantially deſcribed. (*b*) Tab. 6. Fig. 1. (*c*) Tab. 4. Fig. 3. (*d*) Tab. 8. Fig. 2. (*e*) Tab. 7. Fig. 1, 2.

This very wonderful flight of this Inſect, living in this form and ſhape but Five Hours, I have for the firſt time ſeen in a Branch of the *Rhine*, running by *Cuilenborch* in the Year 1667. I find alſo in *Clutius*, who hath writ of theſe Inſects, that they are alſo found at *Arnhem*, *Zutphen*, at the *Cut* by *Utrecht*, at *Rotterdam*,

terdam, and ſeveral other places. As alſo that D. *de Mey* hath given a particular narration thereof, as may be found at the end of the Hiſtorical Obſervations of *Goedaert*. And not only in our Age, but in ſome Ages paſt mention hath been made of theſe or the like Inſects by the Philoſophers, as by *Pliny*, *Ariſtotle*, *Ælian*, and others, who have made ſearch into the nature of Inſects, and by whom this Inſect is deſcribed under the name of *Hemerobius*, *Ephemerus*, and *Diaria*, as appeareth in their writings; as alſo in the forementioned Book of *Augerius Clutius*, publiſhed *An.* 1634. But what degree of knowledge they have had of this Inſect, and what for truth they have recorded thereof, will appear to thoſe who ſhall take the pains to examine them according to this Treatiſe.

The Eggs of the *Ephemeron* being in the forementioned manner ſhot in the water, and beſprinkled with the Milt or Seed of the Male, they ſink gradually, and are by means of the ſtreaming water ſpread here and there on the clay or ground; as alſo for that by their ſhape, which is a (*f*) flattiſh round, they are fitted for a ſpreading in their ſinking; and therefore if with the point of a knife you ſhall let them down leiſurely in the water, you will find them neatly ſeparate one from the other.

(*f*) Tab 4. Fig. 1.

How long theſe Eggs remain under water unhatched, or in how many days the tender limbs of the worm are ſo far grown as to have ſtrength to break through the ſhell or skin, is very difficult to be declared, notwithſtanding by often digging in the Clay, in ſearch for them, or by keeping ſome of their Eggs in a veſſel with Water and Clay, ſome knowledge thereof might be attained. It ſhall ſuffice for the preſent to ſay, that the Egg of the *Ephemeron* produceth a Six-legged Worm, which the Seamen and Fiſhermen name **Oever Aas**, or **Shore-baite**, as hereafter ſhall be mentioned.

CHAP. II.

Out of the Egg of the Ephemeron *proceedeth a Six-Legged Worm.*

THE Time when the Worm is hatched and named **Aas**, or **Bait**, being to me unknown; I will proceed in my diſcoveries; and firſt, if after ſome conſiderable time you dig in the Clay about the places where theſe worms are, you will find a great number of Six-legged and very ſmall worms; which differ not in form and ſhape from thoſe which are bigger: I ſaid, a conſiderable time, becauſe they grow but ſlowly, for in the following year in the month of *June*, when the full grown Worms ſhed their Skin, theſe Worms are in ſize but of about (*a*) one *Holland* inch long, *viz.* ; part of the length of the (*b*) full grown Worm. (*a*) Tab. 1. Fig. 1. (*b*) Tab. 1. Fig. 3.

Beſides theſe Two ſorts of Worms ſo conſiderably different in ſize, there is at the ſame time alſo found in the Clay a (*c*) third ſort, which exceed the ſmalleſt ſort, being double the ſize of them, and are leſs than the full grown. Beſides, thoſe of each Size and Age differ ſomewhat in length and thickneſs among themſelves. So that whereas the full grown Worm at the time that it is ready for flight is about Three *Holland* inches long, the middle ſort are about Two of the ſame inches long, and the ſmalleſt about One inch. (*c*) Tab. 1. Fig. 2.

There is alſo this further difference as to their Age, that thoſe of the (*d*) firſt ſize have not only no wings, but alſo no appearance of them; but in the ſecond ſize the (*e*) wing-caſes appear, which in the third ſize are fully and plainly viſible, (*f*) and as a flower in its bud, growing on, and as it were creeping out. (*d*) Tab. 1. Fig. 1. (*e*) Tab. 1. Fig. 2. (*f*) Tab. 1. Fig. 3.

CHAP.

CHAP. III.

The Worm being hatched what its First Action is, and what its Food.

HAVING obſerved what kind of Worm is hatched out of the Egg of the *Ephemeron*, I ſhall next deſcribe what the Worms thus hatched firſt do, and what is their Food.

It is very requiſite to know that the Worms rarely or never are found on the ground of the Rivers, or Swimming in the body of the water, for notwithſtanding they Swim indifferently ſwift, and make a kind of a Snake-like motion in the water, bending ſometimes their heads downward and ſometimes upward, which waved motion the body followeth, yet they keep themſelves always cloſe the ſides or banks of the Rivers, in the ſtilleſt places of the water where they have their Cells. And where the places dug for finding them are moſt Clayie, there are they found in greateſt number; yet are they ſeldom found on the outſides of the Clay, but they have their habitation within the body thereof, and that in oblong round cavities which themſelves have made, not ſloping downwards, but ſtraight and horizontal, and therefore *Vander Kracht* in *Clutius* ſaith true, that theſe Inſects have each its proper Cell.

As the Bees by an admirable and poſſibly inimitable art make their own Cells out of Wax; in like manner are theſe excavated (*a*) Cavities like Tubes made by theſe Worms, and digged out according to the ſize of their bodies: wherefore as ſoon as theſe Worms are forced out of their Cells and have nothing to creep on but the Surface of the Earth, having no ſupport for the ſides of their Bodies, they ſoon loſe their readineſs and ſwiftneſs of motion, notwithſtanding they are ſur-

(*a*) *Tab.* 2. *Fig.* 2.

rounded

rounded with water, and by means of Swimming can keep themſelves up; yet have I found when I had taken a great number of theſe out of their Cells for to Diſſect them, that they always fell on their backs, where they ſeemed to ly as unable to raiſe themſelves again on their Legs; whereas on the contrary they being in their Tube-like Cells, move very ſwiftly backwards and forward and all manner of ways. And the ſame I have alſo found common in all ſorts of worms, that live in ſuch excavated Cells, which move very ſwiftly in them, but taken out ſeem to lye as fainting away. As I have alſo found in the Worms which live in excavated holes of Trees; as alſo in thoſe which are found in Fruits, Excreſcences of Leaves, and in the wart-like Excreſcences of Plants. It is very obſervable that a Wood-worm when drawn out of its Cell, immediately ſpins a web about its whole body, by which means it is aſſiſted to make a new opening or Cell in the Wood, which without this ſupport of its body it could not do, having herein need thereof to preſs its body againſt it.

The Worm out of its Cell is ſo weak, that Swimming in the water, and reſting there a ſmall time, immediately and without order it ſinketh to the ground and there remaineth lying on its back.

But to proceed, the Worms as ſoon as hatched betake themſelves to bore their Cells, the which as is ſaid they make in the Clay, oblong, ſometimes ſtraight & ſometimes crooked, which they by degrees inlarge according to the increaſe of their body in bigneſs; ſo that the old Worms live in (*b*) wider Tubes or Cells, and the young Worms in (*c*) narrower. (*b*) Tab. 2. Fig. 2. AAA (*c*) Tab. 2. Fig. 2. BB

To this purpoſe the wiſe Creator hath furniſhed them with fit members; for beſides that their Two Fore-legs are formed ſomewhat like thoſe of the ordinary Moles or the **Eve-Chur**, or *Grylo-talpa*, he hath alſo furniſhed them with two Toothy Cheeks, ſomewhat like the Sheres of Lobſters, which ſerve them more readily to bore the Clay.

The

The Worms being placed in a Veſſel with Clay mixed with ſome water, you will immediately ſee them begin to make their Cells, and if it happen you provide them not Clay enough, they cannot hide their deſign, but will be continually wrooting the Clay through and through, and hiding under the Clay ſometimes their head, ſometimes their body, and ſometimes their tail, always endeavouring to make new Cells.

The Fiſhermen aſſure us from their experience that when the water of the River falleth or runneth off, they then bore their Cells lower and deeper in the Clay, and when the water again riſeth they alſo riſe higher; which I judge to them moſt needful, in conſideration of the many Lungs and Air-Veſſels in theſe Worms, for to ſupply which they muſt oft take freſh air, which they could not do, if they remained in the depth when the water roſe.

I have often experienced that theſe Worms taken out of their holes and placed in wet ſand, do then rather creep out of the water than go downwards toward the bottom under the ſand, which they ſeem to do as well for want of Clay, as for the warmth of the water which ſeemeth hurtful to them.

Concerning what their *Food* is, is difficult to find out except by help of Anatomy, which hath taught me their Food to be only Clay: for at what time ſoever they are opened, in their Stomach is found Clay, as alſo in the thick and ſmall guts, in the ſame manner likewiſe is always found in the Inteſtines of Earth-worms, earth and ſand; of which when they have fed, they eject the remainder in a Crooked knobby form, as is to be ſeen in the entrance of their Cells.

As for the *Moths* which eat Wool and Furr, there are two things very conſiderable, and ſuiting very well with this relation; the firſt, that the Cells they make to themſelves, wherein they live, and with which as their houſe, *Tortoiſe*-like, they move from place to place,

they

they make of the matter next at hand; the second is, that they feed also on the same: therefore when you find their Cells, or rather coats or cases to be made of Yellow, Green, Blew or Black cloth, you will also find their dung of the same colour: So that desiring to have most fine Chopt Cloth, you need but seek it in their dung, and it were not possible to find finer shred flowers or herbs than in the dung of those Insects that feed on them. Which possibly might be of good use for the better extracting the Colours and Vertues of Vegetables, which appeareth after it hath rained for some days, at which time the dung of these Insects is in that manner melted, that then walking through the Gardens, you will discern on the Linnen laid on the ground for Whitening, spots of several colours which are very hard to be got out again. In those Boxes in which the *Druggists* and *Apothecaries* keep their Drugs, you will sometimes find some Ounces of these Evacuations, out of which might be extracted the vertue and colour of the Vegetable, whereas mistakingly they are often sold for the Seeds of those Drugs.

Like as the *Moth* feedeth on the same substance whereof it maketh its Cell or Case, so do also our Worms; but as I said, this is not to be discovered but by Dissecting them: which way of certainly knowing the Food of any Insect or other creature, hath not its only use in these Insects, but also in Fowls, Fishes and other Animals, which we may desire to preserve and nourish. And for the knowledge of what their food is, we may in the ordinary way be much to seek. It hath also its use concerning hurtful and much damage-causing creatures whose destruction we therefore are desiring. In this manner I find commonly in the stomach of the *Mole*, parts of Ground-worms, which they very greedily eat, and for which cause alone they seem thus to wroot in the earth. It will be therefore an easie way to destroy them, if with the blood of a *Mole* you mix some *Ratsbain* and chopt Ground-worms, as experience

perience hath taught: to get the blood of a *Mole*, clip off a piece of his Nose, whereat much bloud will issue.

CHAP. IV.

How long this Worm feedeth: why named Asp *or* Baite: *And how strong its life is.*

HAVING described the Egg, the Worm, and its Nourishment; the next thing remarkable will be, to consider how long it feedeth. For notwithstanding it may seem strange to limit the duration of a Creatures feeding, whose life is as to us wholly hid in the earth and water; yet it is not unfeasible by considering the differing sizes of these Worms. For whereas the smallest size worms after one years feeding, are in length $\frac{1}{4}$ of one *Holland* inch; and that the second size are then in length 1 and $\frac{1}{3}$ of the same inches, it followeth by consequence that every Worm is Three years feeding, before it is fitted for its change, at which third year the Worm now full grown is $2\frac{1}{2}$ inches long.

These full fed and full grown Worms now quit their Cells and the water to fly in the air, as following I shall describe. But as no creature is without its enemy, in like manner these Worms when they take the water to attain their flight, are immediately preyed on by the Fish; and although they have escaped that danger and attained the use of their wings, yet are they not free from a second danger, namely, of being preyed on by Birds; which hath given occasion to some Seamen, Fishermen and other people, dwelling on the Banks of the *Rhine* observing the same to use these Worms for a bait to fish with; which therefore is the

true reaſon why theſe Worms are named **Aas** or *Bait*, and **Otter Aas** or *Shore-bait* by thoſe who live about *Wyk te Deurſtede*, *Cuilenborch*, and other places. And from hence alſo it is that when theſe Worms are become Fledg'd and have taken the Air, they are in the aforeſaid places named **Vluchtich aas** or *Flying bait*, whereas by thoſe of *Rotterdam*, *Schoonhoven*, and *Dordrecht*, the oldeſt City in *Holland*, this Worm being Fledg'd is named **Vatt**, from whence that ſo much known Low-Dutch Proverb is derived, **Het ſiet ſo dicht als Vatt**, they are in multitude like *Haſt*, for theſe Worms thus fledg'd flie in multitudes like the falling Snow.

At all times of the Year when the Seaſon is fit for Fiſhing, theſe Worms make a good Bait; for becauſe they live Three years in the water and clay before they take their flight, they may at all times of the year be dug out of the clay in thoſe rivers for that uſe.

When the Fiſhermen bait their hooks with theſe Worms, they fix their hook in the head of the Worm where it is hardeſt and ſtrongeſt, and for that it lives long, it is the more uſeful by its motion in the water to allure the Fiſh, to ſwallow the hook.

The ſtrength of this Worms life may be diſcerned by this Experiment, that when once for drying and preſerving one of them, I had pierced the head through with a pin, it yet lived the next day, notwithſtanding I had put it the whole night before in a Veſſel with Urine for to kill it: yet nevertheleſs being taken out of their Clay Cells, and put in a Veſſel with water and clay, they live not two dayes. When theſe Worms therefore are to be preſerved, they muſt only be placed in moiſt ſand or wetted clay, in which I have found the greateſt ſort to live Four days, and the ſmall worms Eight days, but wholly under water they cannot ſubſiſt.

For ſending theſe Worms elſewhere, there is no better way than to bind ſome of the greateſt hollow Reeds,

Reeds together, and to cause the worms to run in them, wherein they will remain without hurting one another, which otherwise they are subject to do, when moving nigh one the other; and this way they might be removed into other Rivers, as Fish are removed.

CHAP. V.

A Description of the members, or outward parts of the Worm, its Colour, and Nature.

BY a strict examination of the Worm, I find it distinguished into Fourteen annular incisures or divisions, whereof the First containeth the Head, the Three following the Breast, and the last Ten the Belly, with its appendant Tails.

(a) Tab. 2. Fig. 1. A In the (a) Head are observable the (A) Eyes covered with an entire smooth Film, having on each side its brushy hairs. When the Worm sheddeth its Skin, this Film sheddeth also gradually from the Eyes, which eyes when the worm is fledged appear like a net. Somewhat lower under the eyes appear the two tender and BB sharp-ending (BB) horns, which are as it were distinguished into several Joints. Next appear the (C) C Toothlike sheres or cheeks which constitute the Beak, at whose beginning underneath appear several other hairy and filmy parts, which have some similitude with those found in *Lobsters* and *Prawns*.

D At the first ring in the Breast are joyned the (D) Two foremost legs, in which is observable their shape and their Joints. Their shape is somewhat like those creatures which wroot in the Earth, and therefore these feet have their strongest motion outwards, whereby like *Moles* they may the better dig away the earth.

Every Leg hath four joynts and one Nail; the firſt joynt is joyned to the Breaſt; the ſecond joyned to the firſt, is ſomewhat bent, as is alſo the third; but withall of a more horn-like ſubſtance than the other, and having ſmall points ſticking out like teeth of a ſad Red colour, and with many hairs on the ſides. The fourth joint is very ſmall and armed with a Nail, in which are very neatly placed the ſmall muſcles with their inſertions, which very curiouſly move the joints of the horn-like bony legs.

At the Second ring of the Breaſt, being the third of the body, which ſeemeth moſt properly to repreſent the Back, and which is covered above, and under with a horn-like bone, appear faſtned the (*D*) ſecond pair of Legs, containing each five joints, and one nail, here and there beſet with hairs. Somewhat more backward appear on each ſide the (*E*) knobs, or wing-caſes, in which are incloſed the firſt pair of wings: Theſe are here and there interwoven with Air-veſſels which appear on the outſide like common Veins, or Nerves. When the Worm is ready for ſhedding its Skin, theſe incloſed wings neatly and curiouſly folded appear through theſe incloſing films or caſes. D E

At the Third Ring of the Breaſt being the Fourth of the Body, appear the Second pair of wings which are much ſmaller, and wholly covered with the firſt pair, which alſo in a manner cover the laſt pair of Legs, containing alſo each five joints and one nail, and beſet with ſeveral hairs for adornment.

The Firſt Ring of the Belly, or the Fifth of the whole body, appeareth ſmooth and even, without conjunction of Legs, Wings, or ought elſe: To the Six following Rings on either ſide of the Belly are neatly adjoyned (*FF*) the always trembling and moving *Gills*, with which according to *Clutius* the Worm ſwimmeth; but miſtakingly, for theſe parts are truly the Gills of this Worm: in *Crabs*, *Lobſters*, and the Zeehatten, FF

which

which in many things agree with the form of these Worms, are found the same parts, and placed almost in the same manner, however with this difference, that in the *Lobsters* and *Crabs* they are inclosed in the hard Scale that covereth its back, and that in them they are placed higher in the body than in our Worm, as it also is in the Scharatten. In the Figures of *Krachi* are Twelve of these Gills, represented on each side, but by mistake, for there are in all but Twelve, *viz.* Six on each side.

The Eighth and Ninth Rings of the Belly, or the Twelfth and Thirteenth of the Body, are wholly smooth and even, but the Tenth Ring of the Belly, and
G Fourteenth of the Body is adorned with (G) three hairy and bushy Tails, besides two crooked appendices which in the Females are not so visible, and in the Males have some other appendices.

As to the Colour of the Worm, the smallest are of a pale Blue, somewhat inclining to Grey, which rather proceedeth from the transparent Intestines, than from the true Colour of the Worms outside; also the eyes in all these Worms are a Brown black, and the Black is speckt with pale Brown speeks, the which according to the age of the Worm grow blacker. The Beak of these Worms is pale, with sad red teeth, as are also the Two tooth-like Sheres or Cheeks, which are as it were a part of the mouth: the hornlike bony parts of the Legs and the Nails of the feet, are likewise a sad Red.

The Wings which as it were bud forth change gradually from a Pale into a Yellowish Colour, which in time further changeth into a Brown blue, till at length it becomes of a Browniſh black. The whole Worm in time attaineth a pale Yellow, and the Blackish spots on its back, which constitute the upper parts of the Belly, are gradually changed into a deeper Colour.

Next in this Worm is to be considered the Sex. The
(*a*) *Tab.* 2. *Fig.* 1. (*a*) Male hath its Eye in largeness double to that

of

of the (*b*) Female. The body of the Male is commonly much leſs than that of the Female, which according to my obſervation is the ſame in all Inſects, and is ſo contrived by Nature, or rather by the Omniſcient God of Nature, that for the great number of Eggs the Female beareth, it might have a ſufficient containing place. The Tails of the Male are the longeſt; beſides they have three or four other appendices which in the Female are hardly viſible, and of which ſome appear on the ſides, and ſome under. The Male repreſented in the firſt Figure of the ſecond Plate is the biggeſt I have ever ſeen, notwithſtanding of Females many larger are found. (*b*) *Tab.* 1. *Fig.* 3.

Concerning the Nature of this Creature, I pretend to little experience thereof, only I can aſſure you that among all the diverſe ſorts of Inſects I have been acquainted with, I never met with one better natured and more harmleſs than this; for how often or how much ſoever it is touched or handled, it ſeemeth always to be well pleaſed; and left at reſt, it immediately betaketh to its work of making its Cell. Only I have obſerved in the ſmalleſt ſort, that when they are handled ſomewhat too hard, they bend their head toward their breaſt, and thereby make themſelves as it were ſtiffer: Among all its actions, none is more ſtrange than the motion of its Gills, of which it hath on each ſide of its body (*c*) Six, which are moved ſo orderly and continually trembling, that it is admirable. (*c*) *Tab.* 2. *Fig.* 1. *FF.*

CHAP.

CHAP. VI.

The Anatomy of the inward parts of this Inſect.

HAVING deſcrib'd the Egg, the Worm, its Nouriſhment, & duration of Life, its outward parts and its nature; I could now fitly proceed to its Change; but for that this Change is ſo extreme ſudden as conſiſting alone in the ſhedding of two Films, and ſome members, I judged it better for the more clear underſtanding of the difference between the Inſect ſwimming, and the ſame Flying, (that is, between the Worm and the Ephemeron) firſt to conſider the inward parts, the rather alſo for that we diſcern the ſame parts in both forms of this Inſect.

And now that I have undertaken to deſcribe the inward parts of the Worm, and that to effect it, I enter in a path untrod before, yet will I not with *Clutius*, bewail the want of Books Treating hereof: for beſides that Nature it ſelf beſt diſcovereth its wonders, and the Books are ſo far only to be received, as they agree with the truth of the natural appearances of things; I therefore pity thoſe who depending on the experiences of others receive alſo therewith their endleſs untruths, and therewith deceive their Readers. Secondly it is impoſſible, in the variety of Experiences, by our Conceptions and Reaſon alone to keep the right path of truth, and with a clear Judgment to paſs a true ſentence on the obſervations of others; the more for that we find the moſt certain Experiences not agreeing with our judgment, or rather prejudice, to be obſtinately rejected: wherefore I appeal to the Experiences themſelves, notwithſtanding I might complain, that for want of a ſufficient number of Worms, I could not Anatomize their parts to a full exactneſs, nor to my

my own ſatisfaction. But afterwards I have learned that the Works of God are unſearchable and incomprehenſible as is his Being. Wherefore we need not further ſearch into theſe his Works, than with admiration of our ignorance in the ſame, to Praiſe and Love their Maker.

That I may as much as is poſſible clearly repreſent my Obſervations, I ſhall withal deſcribe the manner I have uſed in the Year 1670. to attain the true Diſſection of the parts of the Worm, for I will at no hand either deceive my ſelf or others. But before I proceed to the deſcription of the Inteſtines, I ſhall to aſſiſt the memory, in ſhort, enumerate all the outward parts obſervable in the Worm, and then, which are the inward parts in the Male, and which in the Female.

The outward parts of the Worm are the Head, the Scull, the Horns, the Eyes, the Teeth, the Beak, the Tongue with its hairy Films, which appear in the Worm in the ſame manner as in the *Lobſter*; the Breaſt, the Legs, the Nails, the Wings, the Belly with its appurtenances, the uppermoſt twelve Gills, and the under ten Finns, the Tails with their appendices, and laſtly the openings of the Air-veſſels under the breaſt.

The Inward parts in the Male beſides the Bloud and the Films, are the Muſcles, the Fat, the Stomach, the Guts, the Lung-veſſels, the Heart, the *Medulla ſpinalis*, and the Seed-veſſels.

In the Female having the ſame parts, is alone this difference, that in ſtead of the Seed-bladders or Milt, is found the Egg-cluſter, which is incloſed with thin Films, throughout woven with very many air-veſſels.

But whereas for want of a ſufficient number of Worms, I have not exactly enough examined the inward parts of the Head and Eyes, I ſhall therefore ſpeak little of them, as alſo of the parts of the Breaſt which for the moſt part is filled with the Muſcles of the Legs and Wings.

When a Male Worm (eaſily diſtinguiſhed by the largeneſs of its eyes) is placed on a ſmall Deal board, covered either with black paper or linnen which ſpotteth not, with its belly upwards, and there fixed with a very fine Needle, you will find immediately iſſue out of the wound in the Skin, a thin watery moiſture which is the true bloud of this Worm, however it appeareth not of a Red colour as in Earth-worms, in which, as in Four-footed Animals it is Red. To open the Skin, there is nothing more fit, than a very ſharp and fine ſmall Sciſſers, for that the Lancets, although never ſo ſharp, are not in this work uſeful, for they alwayes tear up ſome of the parts and ſtrain them aſunder; eſpecially when they are of unequal hardneſſes.

When with a ſharp fine Lancet, or the point of a ſharp grounded Needle, you leiſurely and with patience ſeparate the upper Skin from the under parts, then appeareth immediately the under Skin very thin and filmy, which, raiſed with diſcretion, the Muſcles of the Belly appear, and not only thoſe Muſcles which extend in a ſtraight line from one Ring of the Body to the other, but alſo thoſe which are placed oblique, and tranſverſe, and others alſo which ſerve to the motion of the Gills, the ſecond Film appeareth alſo like threads, and ſeemeth to be faſt joyned with the forementioned Muſcles.

Next the Muſcles, appeareth and is faſt joyned to them a very fine and thin Film, which I judge to be the *Peritoneum*, above and under the ſame appeareth the Fat, which is compoſed of ſmall and very thin White bladders, which contain in them the true Fat, in the form of a liquid Oil; when theſe bladders are viewed without a Microſcope, it would eaſily be judged they were the Fat it ſelf, whereas they are but as the thin and extreme tender Veſicles thereof, which contain that liquid Fat. Like as it is alſo in man, and all other beaſts, as will appear when theſe Fat-containing Veſicles, which are of a like proportionate magnitude

ſhall be view'd by a Microſcope. The younger the beaſts are the better this Fat appeareth, for then it is ſpread here and there on the Films, and not ſo cloſe placed up together as in beaſts of more Age.

Next appeareth the (*a*) Stomach, with the Guts thereon depending, *viz.* the Throat-gut, or *Gula*, otherwiſe the upper Gut of the Stomach, which ſhooteth forward in the form of a thin thread from the Mouth or Cheeks through the back and breaſt, and conſtituteth the upper part of the Stomach. Where this ſmall Gut is joyned with the Stomach, it appeareth commonly ſtraitned, (*A*) which alſo appeareth in the lower part of the Stomach, otherwiſe the nether (*B*) mouth of the ſame. (*a*) Tab. 4. Fig. 1. *A* *B*

The Stomach (*C*) notwithſtanding it is compoſed of ſeveral parts, yet ſeemeth to be conſtituted of a thin and very tender Film inwardly beſet with rimples or very neat pleats, outwardly it appeareth wholly ſmooth and extended, eſpecially being filled with food, or blown full of Air with a fine Glaſs pipe; Veins and Arteries there appear none, for the watery colour of the bloud hindreth the diſcerning of thoſe parts, and for which cauſe theſe Inſects are named Exanguious, or without bloud. *C*

Notwithſtanding the (*C*) Stomach appeareth ſupplied with many ſmall Veins which ſeem to be bloud-veſſels, yet being viewed with a Microſcope they clearly appear to be branches of the (*b*) Lung-veſſels, which communicate their Branches not only to the Stomach, but to all the outward and inward parts of the body, ſo that the very Bones and Nails are furniſhed therewith. The (*c*) Guts adjoyned to the Stomach appear both in form and conſtitution threefold, as the inward bended or (*DD*) thin Gut. The thick or (*E*) pleated Gut, and the ſtraight (*F*) or terminating Gut, within the thin Gut, ſomewhat low backwards appear ſome Pleats (*G*) like half circles in the ſame manner as the Valves in the thin Guts of men, where they *C* (*b*) Tab. 3. Fig. 1. *AA* (*c*) Tab. 4. Fig. 1. *DD* *E* *F* *G*

they are named by Anatomiſts *Annular* or *Conniventes*. Somewhat lower where it formeth the (*E*) thick Gut appear ſomewhat long ſtrokes, which are very neat and lively, like ſo many long and extended Muſculous threads in the hollow thereof, which agrees ſomewhat with the **Boeck**, which in four-footed Creatures is a part of the Paunch; next followeth the (*F*) ſtraight Gut which appeareth very neatly pleated, till it extendeth as it were out of the body with an indifferent opening at that end by which the Excrements are ſent forth.

C The (*C*) Stomach is placed between the 4*th* and
4, 5. 5*th* Ring of the body, where with the thin Gut it takes up all the remaining part of the Belly, as the 6, 7, 8,
6, 7, 8, 9, 10, 11, 12, 13, 14. 9, 10, and 11*th* Rings, whereas the three laſt of the body as the 12, 13, and 14*th* contain the thick and ſtraight Gut. Like as the Stomach is furniſhed with a great number of Air-veſſels, ſo alſo are the Guts, and eſpecially the ſtraight Gut, and that chiefly in that part, where it is furniſhed with (*a*) two Muſcles for preſſing out its Excrements.

(*a*) *Tab.* 4. *Fig.* 1. ii.

And becauſe the Worm is fed with Clay, the Stomach and Guts commonly appear filled therewith. This Clay doth almoſt always appear through the Stomach, the Guts, and alſo through the whole body, but it is moſt viſible through the back; by which tranſparency of the Worms body, it hapneth that the Worm at different times appeareth of different colours, according to the colour of the Clay it feedeth on, *viz.* Paler, Greener or Wanner; or more or leſs digeſted or changed in the Guts.

When the time approacheth that the Worm is to Change into a Flie, then appeareth no Clay at all in the Guts, the ſame alſo hapneth in Wood-worms, the Worms of Bees, Silk-worms, and ſeveral other Inſects, which at the time of their Change become as clear and tranſparent as Cryſtal, and ſome other Inſects are thus tranſparent during their whole life, ſo that their Veins

and Inteſtines with the motions of the ſame within their body can be clearly diſcerned.

Among the inward parts of the *Ephemeron*, are very conſiderable the (*a*) Lung-pipe, the Air-pipe, or Wind-pipe, as the ſame part is named in Birds, Beaſts and Man; this Air-pipe or veſſel is not conſtituted of one ſingle trunk, as in the forementioned Beaſts and Man, but of two chief Trunks, which are placed on each ſide of the body, curving Snake-like, and that not only in the Breaſt, as in our bodies, but alſo in the Head, the Belly, the Legs, and the Wings; ſo that the Stomach and the Guts, together with the Muſcles and Sinews, are as it were fed with Air, which truly is very wonderful, for that the Reaſon for which it is ſo formed, is to us wholly incomprehenſible, and teacheth us that God in the incomprehenſibleneſs of his works is to be adored. (*a*) *Tab.* 3. *Fig.* 1. *AA*

The Fabrick of the Lung-veſſels in this Inſect, as in all other Inſects I am acquainted with, is conſtituted of innumerable ſtiff and curled-like parts, which in the form of knotted Rings are joyned together, and ſo cloſe united by means of very thin films drawn over them, that they very fitly contain the Air in them, and ſend it to all the parts of the body backwards and forwards.

When the Worm ſheddeth its Skin, I believe, the Lung-veſſels alſo ſhed a Skin, notwithſtanding I have not yet ſeen it, for at that time when I hapned to make theſe obſervations, I knew not of it. In the Silk-worms is this ſhedding of the Skin of the Lung-veſſels ſo conſiderable, that all humane underſtanding muſt ſtand amazed thereat: for in that very ſmall time when the Silk-worm ſheddeth its Skin, ſeveral hundreds of Air-veſſels in its body alſo ſhed their Skins, being very thin films, all made up of thoſe Rings beforementioned, which would ſeem incredible in the Relation if I my ſelf had not ſeen it diſtinctly, and had ſhewn it alſo to others.

The Colour of these Lung-vessels is a Pearl colour somewhat Grey, which as they come to change their Skin, changeth into a clear and shining White, for which cause they are much Whiter in the Flies than in the Worms; they spread throughout the whole body, to Communicate Air to all the parts outwards and inwards, so that those two great and remarkable (*a*) Air-vessels, which appear placed on each side of the Worm, send to all parts of the body their Branches, as in the Head (*BB*) to the Nerves and Brains; in the Breast (*CC*) to the Muscles of the Legs and Wings; in the Belly (*DD*) to the oblique and straight thread-like Muscles. As also to the (*EEE*) *Medulla Spinalis*, to (*FFF*) the Milt or Seed-vessels of the Male, to (GG) the hairy Gills, to (*b*) the Stomach and (*c*) Guts, to (*III*) the outward Skin, to (*KK*) the Film of the wings, to (*d*) the Egg-cluster in the Female, to the Film (*MM*) that covereth the Egg-cluster, to the (*e*) Eggs, as they are taken out of the body, and to the (*f*) heart.

(*a*) Tab. 3. Fig. 1. AA BB CC DD

(*b*) Tab. 4. Fig. v. C. (*c*) Tab. 3. Fig. 1. H. (*d*) Tab. 4. Fig. 1. LL. (*e*) Fig. 7. N. (*f*) Fig. 4. TT.

I have had much trouble to discover the outward openings of the Lung-vessels, for they open neither in the Mouth or Throat as in other Creatures, and for that Reason they lessen gradually as they nearer approach the Head, whereas otherwise they ought there to widen, after a long search they seem to me to have their openings, under and in the sides of the Breast, almost in the same manner as I have afterwards observed it in *Grasshoppers*, where these openings are easier to be seen; but here in our Worm, by reason of its living in the Water and Clay, are less, and therefore more troublesome to discover. In the Silk-worms these openings of the Air-vessels are more visible, for they have Ten on each side of their body, *viz.* Eighteen large ones, and Two lesser, which last not having any Brown spots are not so visible, and never appear clearer to sight than when the Worm sheddeth its Skin, when out of all these Twenty openings of these Air-vessels the shed Films thereof may be seen to issue out,

From

From theſe Obſervations, appeareth very clearly the reaſon why our Worms riſe higher into other Cells when the water of the River increaſeth, for that ſometimes they muſt draw freſh Air, and breath, for which cauſe it may alſo be ſaid, that they follow the falling water, leſt they ſhould be too much dryed up by the ſurrounding Air, and that their veſſels through the dripping out water might be in danger of cloſing.

Theſe Lung-veſſels are beſt diſcovered when the Worms have been dead for ſome days, and that their inwards are become blackiſh, for then they appear very clear to the ſight, which happens for that they they are of a Pearl colour, and like new boil'd Silver, and alſo for that through their ſtiff and hard matter of which they are made, they are not ſo ſubject to rot, for which reaſon alſo at that time they better keep their Figure and roundneſs.

When with a Microſcope you view theſe Worms on their Breaſt and Belly, the whole belly ſeemeth as interwoven with Silver-white veſſels: But now to know truly whether they contain Air in them, lay them only in a drop of water, and then cloſe or preſs them with the point of a Needle whereby the incloſed Air will preſently appear; when theſe Creatures are Diſſected under the water, and that with fine Sciſſers you clip off ſome of their Lung-veſſels, they riſe immediately to the Surface of the water, which alſo do all the parts of the veſſels broken off, with their ends upwards; in a dried Worm Diſſected, theſe Veſſels are very eaſily diſcovered, becauſe by their curled-like Rings they remain conſtantly open, how much ſoever the other parts dry up.

One of the moſt remarkable things obſervable in theſe Lung-veſſels is the great number of them extending to the (a) Gills where are (PPPP) three chief of them repreſented as cut off; the middlemoſt is always (QQ) black, which notwithſtanding juſt in the middle appeareth tranſparent White, the other two

(a) Tab. 3. Fig. 1. PPPP QQ

appear

appear on each ſide of the middlemoſt which is Black, and they ſhoot out a great number of Silver white
GG Veſſels (GG) in the Gills, which veſſels are not very viſible by their Colour, by reaſon of the very bright ap-
(b) Tab. 2. Fig. 1. FF pearance of the Gills, which are in number Six (b) on each ſide of the body, and are pure ſhining White,
(c) Tab. 3. Fig. 1. RRRR under the ſame, on each ſide are the Five (c) Finns of a Yellow Colour with which the Worm ſwimmeth.

I had made ſome other Obſervations concerning the Gills and their Veſſels, which are miſſing, and which I cannot now find, and the Contents of them is wholly out of my Memory; ſo that I remember not what is
SS the uſe of (SS) that Feather-like hairy part which is ſeen under the firſt and uncut pair of Gills, as alſo whether it is found under the other Gills, what Communication
(d) Tab. 4. Fig. 4. OO TT thoſe Gills have with the Lung-veſſels, and the (d) Lung-veſſels with (TT) the heart, I know not, ſo that I can relate no more thereof than what is repreſented in this Delineation, where all the Air-veſſels about the heart are not repreſented, to prevent confuſion, only ſome are repreſented whole, and the others
VV (VV) as cut of.

I have alſo in all my delineations, not obſerved an exact proportion as to the ſize of the parts, for that ſeemed to me a too tedious labour and of ſmall uſe; ſo that I have delineated one part ſomewhat larger than the other, never thinking to have made theſe my Obſervations publick, till I had anew more examined them all over, which I alſo afterwards found more neceſſary, as well for the greater knowledge I afterwards attained concerning the parts of Inſects, and alſo a greater readineſs in the Anatomizing of them, but the kind Reader is deſired to pardon what is wanting, which I am conſcious is very much; and who is able in many years to deſcribe this Inſect, and the wonders therein obſervable, which is the reaſon that I Communicate it thus to the world; the more for that I now am reſolved to addict my thoughts more to love the Crea-

tor

tor of these things, than to admire him in his Creatures.

The (*a*) heart appeareth placed above in the back as it is in Silk-worms, the Worms of Bees, Wood-worms, Caterpillars, and other like Insects, here and there it appeareth somewhat (XXXX) swelling out, like as in Silk-worms, and noted by *Malpighius*, and from whence he concludeth, but not rightly, as I conceive, that in the same Worm should be more than one heart; I have seen this heart move in the *Ephemeron*, but very disorderly, and what I have here represented in the Figure is but a part of it, and I have wholly forgotten in what part or division of the body it is placed. (*a*) *Tab.* 4. *Fig.* 4. TT XXXX

The (*b*) *Medulla Spinalis* in this Insect, is like that in all the other sorts that I have yet dissected, very wonderful and observable; it contains Eleven Swellings Oblong and Oval, the First of which representeth the Brains where the ** Optick Nerves very visibly appear shooting forth in the same manner like as the other Nerves of the Body shoot out from the other Ten Swellings, but in greater number from the upper Swellings than from the under. Here and there the *Medulla Spinalis* appeareth very neatly fastned as it were with (ZZ) bands, which are made partly of an horny bone, and partly of a Sinewy substance, as is chiefly appearing in the Breast, where the *Medulla Spinalis* shooteth forth very strong Nerves to the (*aa*) Muscles which move the Leggs and the (*bb*) Wings in like manner as it doth to the (*cc*) Muscles of the Gills and the Finns. (*b*) *Tab.* 3. *Fig.* 1. YYY ** ZZ *aa* *bb* (*cc*) *Tab.* 4. *Fig.* 1. CC

Out of every Swelling or Node of the (*d*) *Medulla Spinalis* shoot always two very strong Nerves which joyn in the next Swelling, and enlarges the same whereby the *Medulla Spinalis* appeareth throughout as if Split and Gaping; but as it is naturally placed in the body that gaping appeareth not, for whereas there the arising Nerves lie close one to the other, they seem not gaping, as *Tab.* 4. *Fig.* 6. may be seen where the *Medulla Spinalis* is represented, as it appeareth naturally (*d*) *Tab.* 3. *Fig.* 1. EE

in

in the body, as also the Fourteen divisions corresponding to those of the body in which it is placed.

When you would see the *Medulla Spinalis* without hurting the Worm, you must blow the same up with Wind from behind, whereby the Swelling Guts will press so strongly against the transparent Skin that you may very conveniently see the Natural position, or shape thereof, and that as well without as with a Microscope, but this is chiefly practicable in the Male.

As all the other parts of the body have their Air-vessels, so hath also the *Medulla Spinalis*, and that in a great number, so that even the Brain and the Nerves, receive a continual refreshment of Air. Whether it hath Veins and Arteries I have not seen, yet I firmly believe it; but in the Silk-worms I have seen it very plainly, *viz.* several Vessels and Veins issuing out of the heart, which I filled with a Coloured Liquor, notwithstanding I cannot hitherto certainly affirm whether they are Veins or Arteries.

(a) Tab. 3. Fig. 1. FFFFF

Concerning the (*a*) Seed-vessels, or Genital parts, they are as visible in the Male-worm the day before he sheddeth his Skin, as in the Male of the *Ephemeron*, which hath shed his Skin; on both sides of the Stomach and the Guts appear these Seed-vessels, which wholly agree with the Milt of Fishes, notwithstanding like the Seed-bladders in men, they are somewhat crumpled and Pipe-like in shape.

In which they also agree with the Seed-bladders of some Four-footed Animals, as with the Moles, Hedgehogs, and the like. The shape of these Seed-vessels are FFFFF (*FFFFF*) oblong, taking up the whole belly as may be seen in the Figure thereof, where some of them is represented without the body and somewhat greater than that in the body, those Vessels contain a very white Milky liquid substance which is the Seed, the Vessels themselves also are very white and constituted of a thin Film, having here and there many Air-vessels interwoven in the same.

In the nethermoſt Rings of the Belly appear two other (*a*) parts alſo, as it ſeemeth pertaining to the Seed-veſſels, which ſeem to have the ſame opening with the Seed-veſſels, and with the (*e*) Guts, which I could not ſo exactly obſerve when I made the Diſſection, for that a great number of theſe Inſects are requiſite to be opened, to repeat the ſame ſearch, and to find that in the following which could not be found, or was omitted in the former, but this number of theſe Inſects is not always attainable. (*a*) Tab. 3. Fig. 1. *dd* *e*

The (*b*) Egg-cluſter in the Female is double, and placed in theſe Inſects in the ſame manner as the Roe in Fiſhes. When with a fine ſharp-pointed Sciſſers the Skin of the Belly is a little clipt of, the (*c*) Egg-cluſters appear immediately, which are placed on each ſide of the Flank of the Belly. In the middle between the ſame appear the (*ff*) Stomach, and the Guts ſhining through, but ſomewhat darkly, which are indifferently faſt joyned to (*MMM*) the Films of the Egg-cluſters; the Stomach and Guts appear the clearer by how much they are more filled with Clay, their nouriſhment; whereby alſo the Eggs are more viſible, which by that difference in colour appear the Whiter. (*b*) Tab. 4. Fig. 3. (*c*) Fig. 1. *LL* *ff* *MMM*

This double Egg-cluſter is ſupplied with an innumerable number of Air-veſſels, which are as it were knit together with a thin Film, encloſing the Egg-cluſter, and by which thoſe Air-veſſels are conducted to the encloſed Eggs. When the Film is ſeparated by the point of a ſharp and a well cutting Needle, and that a part thereof with the Eggs is laid in a Spoon with water, the Eggs immediately ſeparate one from another, and there remaineth a tender bunch (*d*) of very thin Veins as their Fibres, Pearl coloured, which Fibres I conceive for the moſt part to be conſtituted of Air-veſſels. (*d*) Tab. 4. Fig. 7. *g*

The (*a*) Magnitude of the Egg is ſo ſmall, as to be hardly viſible, and therefore ought to be viewed by a Microſcope, being laid on Black or Blue paper which much (*a*) Tab. 4. Fig. 1.

much aſſiſteth to the clear perception of them.

The Form of the Egg is a flattiſh round and oblong, and incloſed in a reaſonable ſtrong Skin, which viewed through a Microſcope appears cloudy; its Colour is White, like the inward Film of an Egg-ſhell: The ſmalneſs of the Egg ſeemeth to be the reaſon why the Worms are Three years growing before they come to their full growth and ready for change.

CHAP. VII.

Signs of the Worms being ready for Change; what is hurtful to it; and to which order of Natural Change it pertaineth.

THE common preceeding ſigns of the Worms Change at the exact ſeaſon of the year, are a Warm and dry Spring, a Mild Winter, little Rain and Snow, and a ſoft gliding water. The particular ſigns that the Worm will ſoon fly, are the ſwelling of the Wing-caſes on the back, which at that time attain a thicker and rounder form than formerly; whereby the watery Gluineſs which otherwiſe is found in the Wing-caſes is now become tougher and thicker, ſo that it now beginneth to attain the ſhape of the Wing, and appear through (*b*) the tranſparent Wing-caſes.

(*b*) Tab. 5. Fig. 2. *A A*

Theſe ſigns are yet more apparent when the Colour of theſe incloſed Wings change from a Pale Yellowiſh

into a Grey colour; and yet more certain, when the Wing-cases can be ſeparated from the Wings, without hurting them; as in *Tab.* 3. (*hhh*) is repreſented, where the Wing is repreſented at large with its natural but rare pleatings.

A further ſign thereof is, when Diſſecting the Worm the Eggs are found to be full grown, hard, and Oval, and alſo when the outward caſe may be clearly ſeparated from the Worm and thereby cauſe it to attain the form of the flying *Haſt* or *Ephemeron*.

At this time all their Inteſtines are cleared of all faeces; the Stomach and Guts containing nothing but tranſparent and purified liquor, which the further from Change they are, the more Clouded and Coloured they are found; their Colour being ſometimes Yellowiſh, and ſometimes dark and Ruſſet; at other times there is found backward in the thick and ſtraight Gut a little Clay, whereas being now ready for Change, they are very clear and tranſparent.

That which retardeth the Change of the Worm, killeth it, and hindreth its Change, is a hard and long Winter, much Snow and Rain, whereby their Cells are cloſed, broke, or covered with Sand, whereby they come forth both fewer in number, and later in the one year than the other. They are alſo hindred by too much drought, which forceth them to leave their Cells, and bore new ones, from all which may be diſcerned what hindereth or furthereth the Worms growth.

Many water and other Inſects are found to be infeſted with Lice; which extendeth ſo far, that even no Creature living either on Land or Water, that hath not its peculiar Louſe, which feedeth on its bloud and moiſture, even from the great Whale to the ſmall Ant.

From what hath been now related of the Signs of the full growth of the Worms Wings, it clearly appeareth to which of the Four Orders of Natural Change, or ſlow growing on of the Limbs it pertaineth; *viz.* to the Second Order, for all the Inſects thereunto

unto belonging, change in the ſame manner like our Worm: Which Second order of Change is, *That the Worm of the* Ephemeron *having quitted its Egg or Shell comes forth a Six-footed Worm, and by nouriſhment received, increaſeth in all its Limbs to a full growth; ſo that now on its back appear the Wings budded out; until it be grown into a* Nympha, *which loſeth not its motion, and afterwards attaineth the ſhape of a Flying Creature, by the ſhedding of its upper Skin or Coat, whereby it now becometh fit for Generation.* As of this and other like Changes I have treated more at large in my Treatiſe of Inſects, where I have enumerated a great number belonging to this ſecond Order.

Angerius Clutius ſuppoſeth that our Worm Changeth into a *Nympha* of the Third Order, and then like the *Nympha* of the Silk-worm it loſeth all motion, which he alſo repreſenteth in Figure, although in truth it is otherwiſe; from whence may appear how eaſily they may be miſtaken, who declining the Truth of Experience, only depend on their own Reaſonings or the Affirmations of others.

CHAP. VIII.

In how wonderful a manner the Worm Changeth into the Haft *or* Ephemeron.

THE time of the Worms Change being come, and their Wings in their (*a*) Cales, having attained their full ſtiffneſs and Colour, and that the Worm is forced as it were naturally to a Change; all the Worms thus fitted and prepared, leave their Cells, betaking themſelves to the water, and out of the water to flight, which commonly hapneth in the Evening between

(*a*) *Tab.* 5. *Fig.* 2. *AA*

between the hours of Six and Seven, as I have observed it in the year 1671. the 13*th* of *June*.

Those other Worms that have not attained that maturity and growth remain yet in their Cells, but those that have quitted their Cells and betaken themselves to the water, make all the speed possible to attain the Surface of the water, which the one attaineth sooner than the other, and then each Worm (*a*) immediately changeth into a (*b*) Winged Creature, which Change or shedding its Skin is so sudden, that by the strictest observation it would be judged that they flew through the water as they are. (*a*) Tab. 5. Fig. 2. (*b*) Fig. 2.

All the Insects that I hitherto am acquainted with have a certain time by the God of Nature allowed them, to stretch out their Wings and to dry them before they betake themselves to flight: and notwithstanding the conceived King of Bees, like our Worm suddenly leaveth his Cell, yet not before he hath for some time in his Cell spread out his wings and dryed them.

But on the contrary our *Hast* or *Ephemeron* is almost in the same Minute a Worm and a Fly, for where you cast your Eye on the Surface of the water, and perceive the water to bubble, you see them as it were flying out of the same.

When in a Boat you lye cross the stream, you may best perceive the bubling of the water, and the rise of the Worm changed into a Flie, out of the water; but how swift soever the hand is in Catching the Worm yet swimming in the water, yet can it not bring it unfledg'd to sight; but if you bruise it a little about the Breast you may bring it unfledg'd out of the water, which practice is wholly necessary if you desire to view it unfledg'd and in its Skin.

But how this sudden expansion of the Wings can be effected is strange to consider, for that they have neither Muscles nor Joints in the midst, being only neatly moulded and pleated together in their cases, and which

which in a very ſhort time muſt ſhed another Film, but how 'tis is difficult to anſwer; for my Conceptions were that theſe Wings ought to have been furniſhed in their middle part with Muſcles and Joints as we find in other Inſects, by which means they very neatly fold up their Wings in a ſmall room, and by means thereof alſo expand them again; as is chiefly obſervable in the Ear-worm, or *Forfica*, which hide very large Wings under a ſmall Shell or Caſe, as if they had none at all; and like as the Ear-worm by means of Muſcles and Joints placed in the midſt of its Wings, can fold them in a ſmall compaſs in manner like the wings in our Worm, and ſuddenly expand them again: I conceive the ſame need of like Muſcles and Joints in the wings of our Worm, but it hath otherwiſe pleaſed the great Creator who is various and wonderful in all his works, and not to be tyed to the ſame means in effecting the ſame thing in the one as in the other.

But yet to ſay ſomething of my own obſervation in relation to the ſwift expanſion of its Wings, I conceive that the water preſſing on all ſides, and being warmer on its Surface than in the body thereof, may much aſſiſt to this expanſion, by reaſon that the bloud at that time moving from the heart to the wings, to aid or effect that expanſion, by the warmth may receive a more vigorous motion; as for inſtance, when one hath a Vein opened in his foot and holding the ſame in warm water, by the warmth of the water his bloud becometh more briskly moved and runs ſwifter out. So alſo while all the bloud and moiſture of this Inſect when it ſwimmeth and ſheddeth its Skin is briskly moved, the ſurrounding water may be very aſſiſtant to add to the motion of the incloſed moiſture, and ſo cauſe a more vigorous expanſion of the wings: Therefore if at that time their Wings are hurt or cut, they ſoon bleed to death, or at leaſt the Wings flag and ſpread no more. And as aſſiſtant to the ready ſpreading out of the wings is alſo the Air which is conveighed into them by a great

great number of Air-veſſels, which may be uſeful to ſtiffen them, and cauſe the moiſture to exhale out. If the Wing of the Worm when it is ready for flight be cut off and laid in a ſmall veſſel with water, it will immediately ſpread it ſelf in the ſame till in a ſhort time it be fully expanded, that it would be ready for flight if it were but dry and ſtiff. I have ſeveral times reiterated this Experiment, and thereby learned in what manner they do expand, for being laid, as before, in the water, (*a*) Firſt the great folds do open, whereupon (*b*) the Wing by degrees becometh extended in its length, and then are expanded the (*c*) long folds of the Wing very wonderfully, till at laſt the (*d*) Wing ſpreads out in its full dimenſions as is repreſented in the (*e*) Figure of the Inſect according to the life, but the repreſentation of the Wing in its folds, and the manner of unfolding was taken by the help of a Microſcope. When the Wings are yet in their folds their Colour is a dark Grey, but as they expand they become lighter Coloured.

(*a*) *Tab.* 3. *Fig.* 1. (*b*) *Tab.* 6. *Fig.* 2. (*c*) *Fig.* 3. (*d*) *Fig.* 4. (*e*) *Fig.* 1.

The manner of the Expanſion of the Wings in other Inſects is quite different from this laſt mentioned as in thoſe of the Dragon-flie, or the *Libella* or *Perla*, as alſo the *Tipula terreſtris* or *Culex Maximus*, and the *Locuſta* or Locuſt, which Inſects have their Wings placed in their Caſes in a very crumpled manner, being neither long-wiſe folded, nor again, Snake-like, as in our Worm, for which reaſon their Wings are expanded with more trouble, and require more time thereto.

In the **Schoen-lapper**, the **Withens**, or the **Capellens** (*which are ſome ſorts of Butter-flies*) is yet another manner in the fold of their Wings, for they are cloſe rumpled together, ſo that no pleats, folds or rumples appear, and neither having in their middle part or ſides any Joints or Muſcles, as hath the Ear-worm, as before is mentioned: beſides the Wings of the **Capellen** are beautified with an infinite number of ſmall Scaly Feathers, which are ſo curiouſly placed one above

above the other, and do ſo wonderfully move the one from the other when the Wing is expanded, that it would deſerve an intire Treatiſe: ſo wonderful is the wiſdom of the great Creator ſeen in the ſhape of theſe Wings, and indeed what would not be wonderful of which he is the Author?

(a) Tab. 5. Fig. 1. The (a) *Ephemeron* having thus quitted the water endeavoureth with all poſſible ſpeed to attain a reſting (b) Tab. 7. Fig. 1, 2. place on land, which having attained, it there (b) ſheddeth a ſecond Skin, a very thin Film from its whole body, *viz.* from its Head, Breaſt, Belly, Legs, Tails, and Wings. And this ſecond Skin ſhedding on land differeth from the firſt in the water; for in the firſt Skin-ſhedding the Worm loſeth wholly its former ſhape, which it doth not in this ſecond ſhedding.

In the firſt Skin-ſhedding, the Skin of the Worm burſting open on its Head & Back, ſuddenly falleth from its body and it as ſuddenly betaketh to flight, but with- (c) Tab. 2. Fig. 1. al loſeth conſiderable parts, (c) all the Gills on both ſides with the Ten Finns under them, beſides theſe Gills thus ſhed there remain no hairs, which diſappear ſo intirely as to leave but very ſmall Signs or points thereof, which on the ſide of the Belly make a kind of a ſmall liſt. It looſeth alſo (C) its Teeth or Sheres, the ſhape of its (DD) Legs, the (E) Wing-Caſes, the (G) Tails, *&c.* So that by this Firſt Skin-ſhedding, it cometh forth wholly like (d) another Creature.

F F
C
D D E
G
(d) Tab. 5. Fig. 1. Tab 6. Fig. 2.

But although this order or method is very difficult, if not impoſſible to be obſerved, in this ſo ſudden Change of the Worm; yet may it with much eaſe be diſcerned, if of a Worm thus ready for Change the Skin be ſlowly and with Art and Care taken of; for then the ſhedded Gills may be clearly ſeen remaining in the ſhed Skin; alſo there may be ſeen the remaining points thereof ſticking out in the Flie; there may alſo be ſeen in the Skin the pits in which they ſtuck; in the ſame is alſo viſible the ſhed Skins of the Air-veſſels of the Muſcles, the Arteries, Veins, Nerves which ſe-

parate one from the other, like ripe fruit that falleth from the Tree.

Further, whereas the Flie in this Firſt Skin-ſhedding hath all its Joints and parts more extended in length, yet the horns barely ſhed their Skin without any further extruſion, and become much tenderer and ſhorter in the Fly than they were in the Worm. But more conſiderable is the Change about the Eyes, for the horny Film of the Eyes which in the Worm appeared even and ſmooth, after the Skin is ſhed in the Fly appeareth like a Net, being an aggregate of many Eyes. The Legs and two Tails after the Skin is ſhed, become double the length, and the third or middle Tail is alſo ſhed with the Skin.

When I ſay that the two Eyes in this Inſect are made of an Aggregate of many ſmall Eyes, which in ſome of theſe Inſects, I have found to be 6 or 7000. and in ſome Inſects ſpread up and down their body, as in *Spiders*, and the *Scorpion* Flie, it muſt not therefore be conceived that they are in Form or make like the Eyes of other known Creatures, or men, for in theſe is found no Humour, but from every Globular partition of the ſame iſſueth a Sexangular Filament which terminates on the Net-like Film of theſe Eyes, and that in the Nerve and Brain, ſo that the manner of ſeeing in theſe Inſects is wholly different from what it is in us, in whom it is effected by a Collection of Raies in the Eye, but in them by means of a Collection of Nervous Filaments, which when they ſee are only touched at the ends of their Convexities by the Viſible qualities and Raies of Light and Colour, as I have mentioned at large in my Treatiſe of *Bees*.

Concerning the ſecond Skin-ſhedding of the *Ephemeron* which ſoon ſucceedeth the firſt, it is obſerveable that the *Ephemeron* in ſeeking a reſting place for to ſhed its ſecond Skin is wholly incurious, reſting on whatſoever is in its way, whether Wood, Stone, Earth, Beaſt or Man, and it is thus effected.

It

It fixeth its Feet armed with ſharp Nails on what it firſt lighteth on, then being ſeized as with a cold ſhivering, the Skin ſplitteth open in the midſt of the back in the horny integument of the ſame, which ſplit increaſes forwards ſo far that the Flie can put forth its head, then it (*a*) draweth forth its Legs out of the Skin, while the Nails of the feet remain faſt to that whereon the Flie had taken hold, which Nails remain with the ſhed Skin, and thereby furthers and facilitate the ſtripping thereof, Firſt the Head and Legs are drawn out of the Skin, as you would pull your foot out of your Shooe, or Head out of a cloſe ſticking Cap, and then the Skin is drawn off the remaining parts of the body, by turning the inſide of the ſame outwards, as we uſually flea Eeles, or pull off a Glove the inſide outwards, and when the Skin is half way over the Wings they are like (*b*) captivated and bound, and ſo remain a ſmall time without any perceptible motion: the remaining part of the body in this ſecond Skin-ſhedding is conſiderably extended, and the Tails become a third part longer than in the firſt ſhedding, ſo that the Tails and Legs at the firſt ſhedding which became a Third part longer than before; are become in this ſecond ſhedding ⅓ longer than they were in their firſt ſhedding, which yet is more conſiderable in the Tails, than in the Legs, for becauſe it is compoſed of many hollow Rings which by extruſion ſhove one from the other, and thereby this ſtretching out is more viſible in them than in the Legs which only lay bent in the Skin, and by the ſhedding thereof become extended in their full length. Further the hairs which in the Worm did thick beſet the Tail, do ſtand now in the Tail of the Flie more thin ſet, and are become finer and thinner, for that they have now alſo twice ſhed their Skins.

(*a*) *Tab.* 7. *Fig.* 1, 2.

(*b*) *Tab.* 7. *Fig.* 1.

The *Ephemeron* having now a Second time ſhed its Skin flyeth again to the water, on whoſe Surface it flyeth ſportingly, ſometimes higher ſometimes lower,

Sometimes ſwifter ſometimes ſlower, and between whiles reſting on its Tails beateth its Wings together, in the mean while its Tails ſupporting it which are hollow and beſet with hairs, and being fill'd with Air, drive and Swim the better on the water without ſinking, the which alſo happens to other Inſects which by means of hairs in and between which the Air being incloſed they eaſily Swim on the Surface of the water as appeareth in the Worms of the *Gnat* and *Gadflie*, yet remain not theſe Tails always thus filled with Air, but become empty thereof if a pin be run through them to dry them, for by that means the Air iſſuing out, they fall in lank and crumpled: there is yet another reaſon that our Flie thus lightly driveth on the water, which is, that in its body it hath a fine bladder filled with Air, except it be ſaid to be the Stomach, now only filled with Air, which I cannot ſtrictly ſay, having not fully ſatisfied my ſelf therein.

To proceed, this is here obſervable, that the (*a*) Male twice ſheddeth its Skin, and the (*b*) Female but once which I cannot confidently affirm, yet have not hitherto obſerved ought to the contrary, for this cauſe the Tails of the Female are ⅓ ſhorter than the Males. Another and more conſiderable difference is, that the Eyes in the Male are double in largeneſs to thoſe of the Female; the third difference is, that the Gold colour of the body draweth ſomewhat more to Red in the Male, than in the Female. Add hereto, that to the great Tails of the Male are four Appendices, which appear like crooked Tags, which in the Female are not ſo viſible.

(*a*) *Tab. 7. Fig. 1.*
(*b*) *Tab. 6. Fig. 1.*

The *Ephemeron* Copulateth neither in the body of the Water, nor on Land, nor in the Air; only the Female ſhooteth her Eggs on the Surface of the Water, on which the Male ſhooteth or caſteth its Milt or Seed; to which end poſſibly it is provided with larger Eyes, that it might the better diſcern the Eggs of the Female in the water. As in like manner many ſorts

of

of Fiſh, without any Copulation, caſt their Seed in the water, which they eject not all at once in one body, but ſparſedly as looſe and ſeparated Seeds. That the *Ephemeron* Copulateth not in the water appeareth hence, for that they come not out of their Cells till ſuch time as they are ready for Change, except they come out to take Air, and it were impoſſible for them to Copulate in the body of the water, for that they cannot keep themſelves up in the water without conſtant motion; for at any time ceaſing their motion they immediately ſink to the ground, where they have no firm abode, till they have bored themſelves new Cells. Add hereto as the ſtrongeſt reaſon, that no Inſect ever Generateth till having ſhed its laſt Skin, at leaſt not by any obſervation of mine.

Neither do they Copulate in the Air, as may eaſily be perceived at the time when they flie; as alſo that it were impoſſible for them to Copulate in the Air, in conſideration that after the laſt Skin-ſhedding the Legs of the Male are extended to that length that *Clutius* judged them to be horns. Conſider alſo what requiſites are neceſſary for to Copulate flying in the Air, as is obſervable in Flies, and chiefly in the *Dragon-flie*, which perform the Act of Copulation very wonderfully flying in the Air.

I conclude therefore my Obſervation, that the *Ephemeron* never Copulateth either in the water or in the Air, but only that the Female having ſhed its Eggs in the water, the Male ſheddeth thereon its Milt or Seed as before is ſaid. All which in that ſhort time of their life in this ſtate is effected in that haſte and ſwiftneſs that it is impoſſible to make a narrower ſearch therein.

During the whole life of this Flie it eateth nothing, as is common to many other kinds of like Inſects, and in ſome others, this not eating continueth for ſome weeks, yea months; as in Frogs, Lizards, Snakes and Camelions, as I have obſerved.

What I have thus obſerved concerning the Generation of the *Ephemeron*, is very conſiderable, but yet that is more conſiderable in the *Snail*, whereof each is both Male and Female together; which I doubt whether it is ſo in any other Animal. And although there are many Relations of thoſe they name *Hermaphrodites*, yet doubt I whether ever any ſuch hath been ſeen. I opened once a Child reputed for ſuch, but well examined, it was found a real Female; notwithſtanding that above the Female parts it had a riſing, out of which it evacuated its Urine, which hapned for that it had no Urine-bladder, and the paſſage of the Kidneys for evacuation was in that place, which cauſed the eaſie-believing and not conſidering people to believe this Child was of both Sexes. Among the Bees are Males and Females, and a ſort that are neither; that we name among them the *King*, is a Female; the Breeder which is a Male, and the common Bee which is neither. The ſame is alſo among Ants. Again thoſe Animals which grow faſt to the Rocks, or live in hard Shells, and ſo remove not from their place, muſt needs have another manner of Generating; all which compared with the Generation of Vegetables having both Sexes in the ſame body, and the power to Generate without Copulation, we may obſerve that the Omnipotent God can produce the ſame thing by ſeveral means and ways.

CHAP. IX.

How long the Ephemeron *liveth, and what it is which haſteneth its death.*

THE *Ephemeron* as before is ſaid, flying up and down on the Surface of the water, liveth in that ſtate but between 4 and 5 hours; that is from 6 a Clock, or half an hour after in the Evening, till Eleven of the Clock in the night following; which I have obſerved by incloſing one in a Box in my Chamber, and with ſome care obſerved the time of its life; in that very ſhort time they all die, and that which is obſervable, none of them all die a natural death on Land; for aſſoon as they have ſhed their ſecond Skin, immediately they flye to the water.

Beſides that the life of the *Ephemeron* in the ſtate of a Flie is ſo ſhort, an infinite number die ere they come out of the water, being devoured by the Fiſh; and of the other who eſcape that danger by flight out of the water, many are devoured by the *Sea-Meawes*, *Swallows*, and other like Birds, while they are ſhedding their Skins and flying; and having eſcaped theſe two dangers, if in their flying they come too nigh the water, or play therein on their Tails, they are caught by the Fiſh; and flying too high in the Air they are caught by the Birds.

When the *Ephemeron* is fledg'd, then are the *Roch* which feed thereon very fat, and of a ſweet and pleaſant taſte, as Dr. *Nic. Tulp* Burgomaſter of *Amſterdam* hath aſſured me.

If the reaſon be asked (the forementioned dangers excepted) of the ſhort life of this Flie, it is to be conſidered that the Eggs in the Worm, while yet in the water are perfect, ſo that as ſoon as the Flie by ſhedding its

its Skin, and extending its members is as it were New-born, the Eggs are ready for ejection. Add hereto that these Eggs when first hatched have no need of the Parents care as in other Animals: and because the only reason of their Change into a Flie seemeth to be for Generation, which effected, the Flie dyeth; and to this end it is for three years growing in the water and Clay, in the form of a Worm, as also to this end it Changeth its Form into a Flie, till having cast its Seed, it endeth its life.

Other Insects, as the Flie of the *Silk-worm*, which are longer-liv'd, appear with their Eggs yet very imperfect and weak, and bear them so long, till they are hard and fit for ejection, and then they also end their life.

Some other Insects, although in time they lay their Eggs perfect, as the *Ants* and *Bees*, whereof the Female-Bee, vulgarly named the *King*, layeth in one year about 6 thousand Eggs, and yet they dye not then, for they must feed their young, and daily with much care and labour provide them food; which labour and Care not being the duty of their Males, they soon die after they have Generated, or else are miserably kill'd by their Consorts.

So that if we should rank all Animals, the Rational or Man not excepted, under one of these Three forenamed Orders of Living; we should reduce Man under the Third sort; for 12 or 13 years pass, before Man is fit for Generation; and also more number of years are required for the Second, Third, 5*th*, 10*th* and last Birth: the rest of the years are required to the necessary Education and Instruction of the Children. So that all well considered, we may say, that for Generation is the Beginning, Middle, and end of Man's life.

CHAP.

CHAP. X.

The Ephemeron *does flye Three days, and ſometimes on the Fourth day. Other ſorts of* Ephemerons.

THE *Ephemerons*, as was ſaid at firſt do flie for Three dayes on the Surface of the water; but with this diſtinction: that thoſe which have riſen many thouſands of them out of the water, and flown the firſt day, die the ſame day: living out of the water in the whole but about Five hours; on the Second day a great number riſe again out of the water, and flye and die the ſame day, and ſo on the Third day; and then all ceaſe till the ſame ſeaſon the next following year.

The truth hereof is known to many perſons, who live near thoſe Rivers, who ſee the ſame yearly; yet I have ſeen them alſo flie the Fourth day, but in no great number; as on the Fifth day alſo; and therefore I judge theſe Worms were later fitted for flight than thoſe that flew before; or were letted by ſickneſs or otherwiſe. As alſo that thoſe which appeared ſooner, were ſooner fit for their flight; and for this reaſon I ſee not but that the *Ephemeron* might appear ſome few days ſooner or later than the preciſe time; for that by experience it is found that they ſometimes appear about 14 days ſooner or later, according as the ſeaſon of the year is more or leſs agreeable.

The other ſort of Inſects have almoſt a like ſet time for their Change, which being come they cannot hinder, as I have often found, and have indeavoured by ſeveral ways to retard their Change but in vain; for the time being come they will force it forward although by the endeavoured obſtruction, it prove their hurt or deſtruction: at which time notwithſtanding by theſe endeavoured obſtructions their Limbs are ſo compreſſed,

that being dead all the pleat-folds of their inward and hidden parts may eaſily be examined, which is of no ſmall uſe for thoſe who labour in the ſearch of theſe things.

If all what is hitherto related of the *Ephemeron* be well conſidered, the ſaying of *Mouſet* will prove true, *viz.* Ἐφήμερον *ſive Diaria mirabilis Muſca eſt, ſive formam ſive vitæ brevitatem ſpectemus.* That the *Ephemeron* is a wonderful Flie if its Form and brevity of life be conſidered; but what he farther ſaith thereof, as alſo *Aldrovandus*, *Jonſtonus* and *Clutius*, with thoſe other Writers that have writ thereof, agreeth not much with truth; except that the Inſect they have deſcribed be ſome other than what we have deſcribed; for there are different kinds of *Ephemerons*, only I adviſe that whoever in theſe matters deſireth truth, that himſelf ſeek it in nature, which exceedeth all Writers, and teacheth us more in a minutes time, than in years can be learned in Books without her. Nature is an open book, in which her wonders are more intelligible than in the relations of men ſubject to many miſtakes, from which I acknowledge my ſelf not free.

I wondered to obſerve in the book of *Augerius Clutius*, that the *Ephemeron* of *Dortman* is only drawn from a weak Memory or fancy, which obſerved by *Goedard* who was informed by many obſervations of that kind, he hath endeavoured to mend, by his own conceit and judgment, but very badly, for he hath changed nothing therein but what he judged to be miſhaped; having left the whole draught which was firſt made only by Memory, as it were; whereby appeareth how inconſiderately the error committed by the one hath been endeavoured to be mended by the other: which for that he only endeavoured to do by his conceit, hath conſequently doubled the error, for that he endeavoured to make it to appear more true-like, and yet he acknowledgeth never to have ſeen the Inſect. Wherefore the great *Harvey* hath well ſaid, *Ex ſenſu permanet ſenſatum; ex permanentia ſenſati fit memoria:*

memoria: ex multiplici memoriâ experientia: ab experientiâ ratio universalis; definitiones & maxima, sive axiomata communia, cognitionis certissima principia.

At the time when I was searching and examining the nature of this Insect, I have seen several sorts of *Ephemerons*, but I have never seen that of **Hoefnagel** represented by *Clutius*, and which also is to be found in the Figures of the said **Hoefnagel**, except once in the way to **Diemermeer** I found the *Nympha* thereof, which was hurt by being trodden on, I judg'd it then to be derived from a black and toothed Water-worm which hath a thick rumpled Skin, and arrived to its full growth, leaveth the water, and creeping on land, there changeth into a *Nympha*; which in time attaineth the shape of the *Ephemeron* represented by **Hoefnagel**, and afterwards shooteth again its Eggs in the water. That there are also other sorts of Insects, and also some kinds of *Ephemerons* which I can shew, as among other, some sorts which I have met with, and caught in *France* in the River *Loire* by *Saumeur*, which in shape differ little from those with us, only much smaller. I have once seen the same Flie in great troops; chancing to walk one Evening on the Bridg over the River by *Saumeur*, some of those which flew had yet fast on their Tails, the Second Skin which they were shedding, with which they flew to and again over the Bridg; I cannot relate more of this sort; nor of the other sorts, of which I have kept some, and of which there are none which live so short a time as doth our *Ephemeron*. Some of those kinds live longer than others do, which causeth me to conclude that there are yet more differences to be observed in them; and therefore that the Writers are not wholly to be rejected that write somewhat of these, and other like Insects they have seen in other Countries, not wholly agreeing with our *Ephemeron*: and it would be a great presumption in us to conclude otherwise, for God is endless in the variety of his Works, which notwith-

ſtanding they here and there differ in ſome accidents, yet in the chief parts they all agree, which is one of Gods greateſt wonders in nature; ſo that it might be ſaid that he had Created but one Animal hidden under ſeveral outward ſhapes, and endleſs wonderful accidents.

Being in the year 1670. in the Village *Slouton* by *Amſterdam* in the month of *June*, where as I walked towards the Evening through the Fields, I met with ſuch an infinite number of ſmall Inſects ſomewhat bigger than *Gnats*, which reſted on my body, that I was even covered therewith. Every one of theſe while reſting on my body ſhed a thin Film, which done they immediately repaired again to the waters, where they, like the greater *Ephemeron* ſport above the Surface of the water. The Original of theſe Inſects is not much unlike that of our *Ephemeron*, for that they alſo live in Ditches and Trenches of water, which alſo at their ſet times Change by ſhedding two Skins; the one in the water, the other on Land. The Worms of this ſmall *Ephemeron* differ herein from the greater, in that they live not in the Clay, or in Cells, but on ſtony and Sandy ground, and are therefore of a ſtronger Conſtitution, than the larger *Ephemerons*, and their Skin agreeing more with that of the *Lobſter* and *Prawn*. They have alſo on the ſides of their bodies Gills and Finns, when in the middle of Summer if you take a ſtone out of the *Rhine* or *Leck*, as alſo out of ſome Inland waters, you will find ſome of theſe Worms ſitting thereon; which is alſo found in other Countries and Rivers: as I have found in the *Loire*, the *Seine*, and other Rivers of *France*: Whereby it appeareth that there are many ſorts of *Ephemerons*, and that therefore thoſe Authors are not to be rejected when they deſcribe an *Ephemeron* differing from ours. The ſaid Worms with what I have beſides repreſented of the *Ephemeron*, I can for the moſt part ſhew any one to the life; for that I have hitherto kept them by me, for a clearer demonſtration of what I have writ.

THE

THE
Explanation of the ſeveral TABLES.

The Firſt Table.

Fig. 1.

IN the Firſt Figure is repreſented the Worm one year old, being in length ¾ *of an* Holland *inch; it appeareth wholly without Wings or any ſigns thereof; it hath on each ſide* 6 *continually moving Gills turned over on its back each againſt the other; whereby the* 10 *under placed Finns may be clearly ſeen.*

Figure 2.

In the ſecond Figure is repreſented the Worm Two year old, in length 1½ *of an* Holland *inch; the ſigns of its Wings or their Caſes, wherein the Wings are incloſed, appearing; the two uppermoſt of them, much bigger than the two lowermoſt; it hath its Gills in a different manner turned over its back, than in the firſt figure, which I therefore note; for that all theſe Worms are repreſented to the life, and withal to ſignifie how wonderful the motion is, which they without ceaſing make with theſe conſtantly trembling Gills.*

Figure 3.

In the third Figure is repreſented the Worm Three years old, in length about 2½ Holland *inches, but among thoſe of this age there is much difference between the length and thickneſs of the one and the other. The Worm here repreſented is a Female, and one of the ſmalleſt ſize of that Sex, which difference of Sex is to be diſcerned in the eyes, which in the Females are much ſmaller than in the Males; the Wing-caſes, in which the wings are incloſed, appear now very plain, notwithſtanding the upper pair ſo much cover the under pair, that at firſt ſight they are not viſible, except the uppermoſt are lifted up; here is alſo repreſented very clearly the* 6 *Gills, on each ſide of the body turned over the back, whereby the undermoſt Ten Finns of each ſide are made viſible; at this time theſe Gills are never without motion, yea even*

out of the water, wherefore ſome have judged that the Worm ſwims by the help of them: But I judge that is performed only by the Finns, as I have named them, placed under them; while for many reaſons I believe that the uppermoſt, which I name Gills, and which agree with the Gills in Fiſh, do cool the bloud in this Worm, as is done in Fiſh.

The Explanation of the Second Table.

Figure 1.

HEre is repreſented one of the biggeſt Male worms, in which all its parts are very neatly and diſtinctly repreſented, as its

A. Eyes double in ſize to thoſe of the Female.

BB. The horns with their differing Articulations or Joynts.

C. The Sheeres, Beak, or toothy Cheek-bones, wherewith they root up the earth.

DD. The Firſt, Second and Third pair of legs with their joints.

E. The Caſes of its Wings in which the firſt pair are incloſed, like a tender flower in its bud.

FF. The always moving or trembling Gills which are ſhining and pure white, and beſet with thouſands of fine hairs like Fur, the ſame are here very neatly repreſented. The Finns in this Figure are not viſible (being covered by the Gills) but are already repreſented in the firſt and third Figure of the firſt Table.

G. The three Tails, beſet with Bruſhie hairs, with their Tag-like appendixes.

Figure 2.

The long hollowed Cells in the Clay in which the Worm liveth, moveth, creepeth, & is fed, almoſt in the manner as the Worms of the Bees in the combs or wax-cells, are here repreſented.

AA. The Cells of the greateſt ſort of Worms in the Clay.

BB. The Cells of the ſmalleſt Worms.

The Explanation of the 3d and 4th Tables.

I have in both theſe Tables uſed the ſame letters, for that the Explanation required it; as alſo for that they repreſent the entire diſſection of the Worm; ſo that what letters are wanting in the third Table may be found in the fourth: as alſo thoſe which are wanting in the fourth may be found in the third.

Expla-

Explanation of the 3d Table.

Figure 1.

AA. THe Lung or Air-veſſels of the Worm, which are two very remarkable & conſtantly open Air-veſſels, compoſed as it were of ſome thouſand of curled-like ſtiff-rings, by which the Air is conveyed to all the inward parts of the Worm; the ſame are placed on both ſides, the length of the Worm, and waved Snake-like.

BB. The Air-veſſels in the head of the Worm; the ſame are branched out of the two firſt mentioned great veſſels, *AA*, and run to the Brain and Nerves.

CC. Branches of the Air-veſſels running to the Muſcles of the Breaſt.

DDDD. Branches of the Air-veſſels running to the Muſcles of the Belly. The ſaid Muſcles are repreſented on the other ſide of the body, wholly void of veſſels, where the oblique aſcending Muſcles in ſome manner cover the ſtraight Muſcles; the uſe whereof is to move the rings of the belly; for driving forward the bloud and humours; and for diſcharging the Guts, in that they aſſiſt the Guts in their motion.

EEE. The Lung-veſſels running to the Medulla Spinalis; where, about the globular parts thereof, they are very viſible.

FFFFF. The Lung or air-veſſels running to the Milt, or Veſiculæ ſeminales of the Male-worm, one of theſe Veſiculæ or Bags are repreſented in the body, as it is there naturally placed; the other is placed out of the body, and delineated ſomewhat bigger than naturally it is, or than that which is repreſented in the body.

GGGGG. The air-veſſels running to the Gills, which appear white like new-boil'd Silver; two of theſe Gills only are repreſented; for that the other ten are repreſented as cut off, to ſhew the ten Finns. See RRR.

H. The air-veſſels running to the lower part of the Guts; as alſo to the ſeed-veſſels next to them dd.

III. The air-veſſels running to the fat, the films, and the outward skin, to cool and ſupply them.

KK. The air-veſſels running to the Wing-caſes, and appear outwardly like ribs or ſinues; their chiefeſt uſe I believe is, by the air conducted there to aſſiſt the expanſion of the wings; to which purpoſe the wings themſelves are ſupplyed with a great number of theſe air-veſſels.

PPP. Three chief air-veſſels running without the body to the Gills, the ſame are here repreſent-

edd

ed as cut off, the better to shew the under placed Finns, beset with brushy hair, RRRRR.

QQ. The middlemost of the three forementioned air-vessels, of the perfect white Gills; which is of a black colour, and appearing through almost in the midst of the transparent white Gills, whereby it seemeth as if the black stroke or line of the Gills, were marked with white pricks.

RRRRR. The five Finns on each side of the body, beset most on one side with dark gold-yellow, and stiff brushy hairs.

SS. A feather-like hairy part, placed under the first pair of Gills; of which I have no remembrance, neither what it is, nor also whether it is found about the other Gills.

TTTT.-The Medulla spinalis *constituted of eleven Nodes or globular partitions, from whence are derived the Nerves running through the whole body; and impart unto it sense and motion; see further concerning this in the 6th figure of the 4th Table.*

ZZ. The places where the Medulla Spinalis *as with strong ligatures is kept in its place.*

***. The Optick nerves arising out of the brain, or otherwise out of the beginning of the* Medulla Spinalis, *at the first globule thereof.*

aa. The Muscles of the breast, moving the legs; whither also some Nerves run from the Medulla spinalis *which communicate to them life, motion and sense.*

bb. Some other Muscles of the breast, but cut through, which move the wings; to which also the Medulla spinalis *sends its Nerves.*

dd. Two members which I conceive are pertaining to the seed-vessels of the male; of which yet I am not very certain.

e. The Rectum *or straight Gut cut off; which is better and neater represented in the fourth plate, Figure 5.*

hh. The very artificial foldings of the wing, as it is folded in the wing case KK. and is not to be seen but about the time when the Worm is ready for Change, by this wonderful manner of folding, and pleating of the wings, they can be again readily unfolded, and expanded as is in some manner represented in the 6th plate, in the 2d, 3d & 4th figures.

Figure 2.

Here are represented all the described parts in their natural bigness.

Figure 3.

The natural representation of the Cell or nest of a Caterpillar, which

which is wonderfully formed; it is somewhat more than a fingers length; at the close end, somewhat sharp, and Pyramidal; it is built or framed of a great number of small round sticks, bitten much of a length, which are piled the one upon the other like the Beams of a Russia-*house, the ends laid the one over, or resting on the other, and are fastned together with a fine Web, instead of Lome or Clay. The true bottom or foundation sticks, have twice the length and thickness of the other, which are thereon piled tower-like. Besides this Nest is also surrounded or covered over with a Web, thick, tough, and of equal thickness, and lined within with a soft down to lye in.*

The Explanation of the Fourth Table.

Figures 1, 4, & 7.

LL. SOme branches of the air-vessels, AA. represented in the former plate, running to the Egg-cluster, or Ovarium.

MM. The air-vessels as they are seen in, and upon the film which covers the Egg-cluster.

N. The same air-vessels together with a part of the egg-cluster, taken out of the body; where very neatly is represented how these air-vessels are joyned to the Eggs, like as the stalk of a bunch of grapes is joyned to each grape.

OOOO. The air-vessels running to the heart; where I have not delineated all the vessels, which are sent from the two great trunks of the air-vessels AA, to prevent confusion, by reason of the very great number that run thereto.

TT. A part of the heart which here and there swelleth out; its natural place in the body is in the back, and runs along the whole back.

VVVV. Some air-vessels cut and broke off which run to the heart and other parts.

XXXX. The parts where the heart swelleth out and wideneth.

cc. The Muscles moving the Six Gills, and five Finns placed on each side of the body, to which do run considerable Nerves to communicate to the same, life and motion.

ff. The Stomach and the Guts, as they appear and swell through the Egg-cluster; the Stomach and Guts are very neatly represented in the 5th figure of this same Table.

g. The form or shape of the Eggs, which are flattish and oblong round.

ii. The Muscles of the Rectum, *or straight Gut, which serves for*

ejecting out of the body, the ſuperfluities of the inward parts.

Figure 2.

Repreſenteth the Eggs of the Ephemeron, *as the ſame appear to the naked ſight without help of a Microſcope, whereas all the other parts have been viewed and delineated by help of the Microſcope.*

Figure 3.

Repreſenteth the double Egg-cluſter of the Worm, made up of an infinite number of very ſmall Eggs, which at the time when the Worm is changed into the Ephemeron, *and flyeth on the Surface of the water, are by the Female ſhot out on the water, and are beſprinkled by the Male Seed. So that theſe Inſects are Generated without Copulation.*

Figure 4.

The Explanation of this Figure is comprehended in the explanation of the firſt Figure of this plate.

Figure 5.

A. A part of the throat-gut, or Gula, *(which conveyeth the food into the Stomach) cut off cloſe to the ſame.*

B. The lower Orifice of the Stomach or Pylorus, *through which the food is ſent into the Guts.*

C. The Stomach it ſelf wherein are repreſented ſome of its air-veſſels which run thereto from the great Trunk, as they are repreſented in the firſt Figure of the third Plate. AA.

DD. The thin gut, which is as a branch of the Stomach, immediately annexed thereto, ſo that the Stomach as it were narroweth into the ſame.

E. The thick or crumpled gut, wherein ſome long ſtrokes or ſtriæ are obſervable, which from within appear through it.

F. The ſtraight gut, which appeareth very neatly rimpled.

G. Some tranſparent Valves, like half moons, which appear in the thin gut, and are ſeen through it.

4. 5. 6. &c. Theſe Figures denote eleven of thoſe annular diviſions of the body of the Worm; and alſo ſhew where the Stomach and the Guts have their natural place.

Figure 6.

The Brain, the Medulla ſpinalis, *and the Nerves ariſing out of the ſame are here repreſented, according to the life; ſo that the Nerves of the* Medulla ſpinalis *appear not ſo gaping, as is repreſented in the firſt Figure of the 3d plate TT. for there they are repreſented, as they appear in a Microſcope, when with a fine Needle, they are ſeparated, which can eaſily be done without cutting or tearing.*

1, 2, 3. &c. *The Figures,* 1, 2, 3, &c. *represent the natural place and posture of the* Medulla spinalis *in the body; and in what manner it is distinguished by the Ring-like indentings, in relation to the head, breast and belly.*

Figure 7.

The Explanation hereof is contained in the Explanation of the first Figure of this plate.

The Explanation of the Fifth Table.

Figure 1.

THis is the Figure of the Male Ephemeron, *having shed its first Skin; or representation of the* Ephemeron *as it first cometh out of the water, where it hath lost its first Skin, and from a Worm is become a Flie, as a Worm it is represented.* Tab. 2. Fig. 1.

Figure 2.

The Female Worm as it is immediately before its Change, is here shewn; in which the Wings are now visible, appearing through their Cases.

AA. The cases of the Wings; which appear through the same very visible. How these Wings appear, when the Case is shed, see in the 3*d* Table, fig. 1. *in the letters* hhh, *where they are at large represented.*

The Explanation of the Sixth Table.

Figure 1.

REpresenteth the Figure of the Female Ephemeron, *just as it rises out of the water, and hath quitted its Skin, and from a Worm swimming, is become a Flie; and its Skin now shed, may be seen driving on the water; as is represented in the* 5 Tab. fig. 2.

I have dryed some of these shed Skins, which represent the Worm so naturally and to the life, as if you saw the Worm alive before you.

Figure 2.

Representeth in some manner how the wings do expand, which to apprehend more clearly, it ought to be known that the wing represented in the first Figure of the third Plate, with the letters, hhh, *is there represented with its natural foldings; and is here represented in the manner how it by degrees doth expand, and loseth its neat pleats and folds.*

Figure 3.

Representeth the same wing losing first its Snake-like foldings, and then its long folds, which are

in

in the manner of a Brabants huik, *or Veſt, firſt pleated in the length, and then folded again croſs-wayes.*

Figure 4.

Repreſenteth the ſame Wing almoſt fully expanded.

The Explanation of the Seventh Table.

THe *ſeveral appearances of the* Ephemeron, *ſhedding or ſtripping off its Skin, like a very thin ſhift or ſhirt, are here repreſented to the life.*

Figure 1.

The Male endeavouring to ſhed its ſecond Skin on land much more leiſurely, than it ſhed its firſt Skin in riſing out of the water, which as is before ſaid, happeneth in a moment. Here is repreſented the body half ſtript, the head, the breaſt and the legs, in the manner as we pull our feet out of our Shooes or Boots: but the Wings are in that manner ſtript, that the inſide of the Skin turneth outwards, and the outſide inwards; which is wonderfully effected: for the Flie is at that time, like a captiv'd and bound bird; for the Skin thus drawn off, ſhutteth cloſe to its body, like a ſtrong Swaſh wound about, which keepeth it as a priſoner, and cauſeth it to ſhiver and quake.

Figure 2.

Repreſenteth the Male Ephemeron *almoſt uncaſed, ſo that the two outermoſt Wings and the Tails, by a ſmall ſtripping off the Skin will become wholly freed.*

The Explanation of the Eighth Table.

Figure 1.

REpreſenteth *the thin Skin or film of the* Ephemeron *in this manner ſhed.*

This film thus ſhed, remaineth not in the form as is here repreſented; for the parts that did incloſe the wings ſhrink commonly up together, and ſo come to appear in another form.

Figure 2.

The Male Ephemeron *having now ſhed two Skins ſucceſſively, and aſſumed the ſhape of a flying Inſect; the Legs which in the Worm were ſhort, are now extended to about twice the length; which chiefly is viſible in the Tails, whoſe length by theſe two extenſions, are now become three times longer than they were in the Worm.*

FINIS.

XLO 555

TAB. I

Fig. I

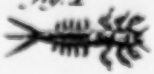

Fig. II

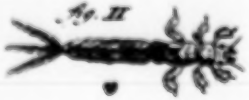

Fig. III.

D. Boshoom sculp.

TAB. II

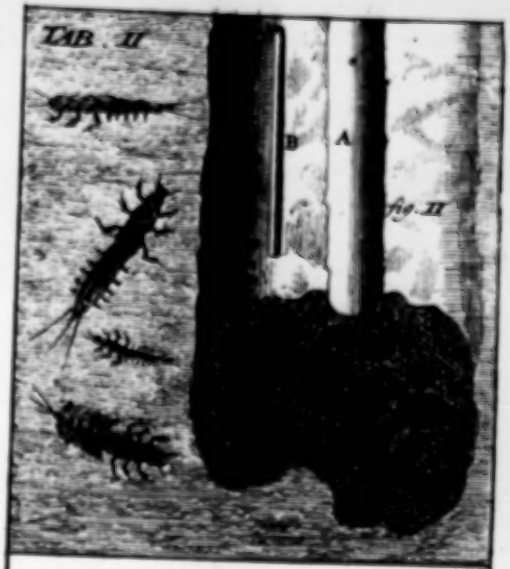

fig. I

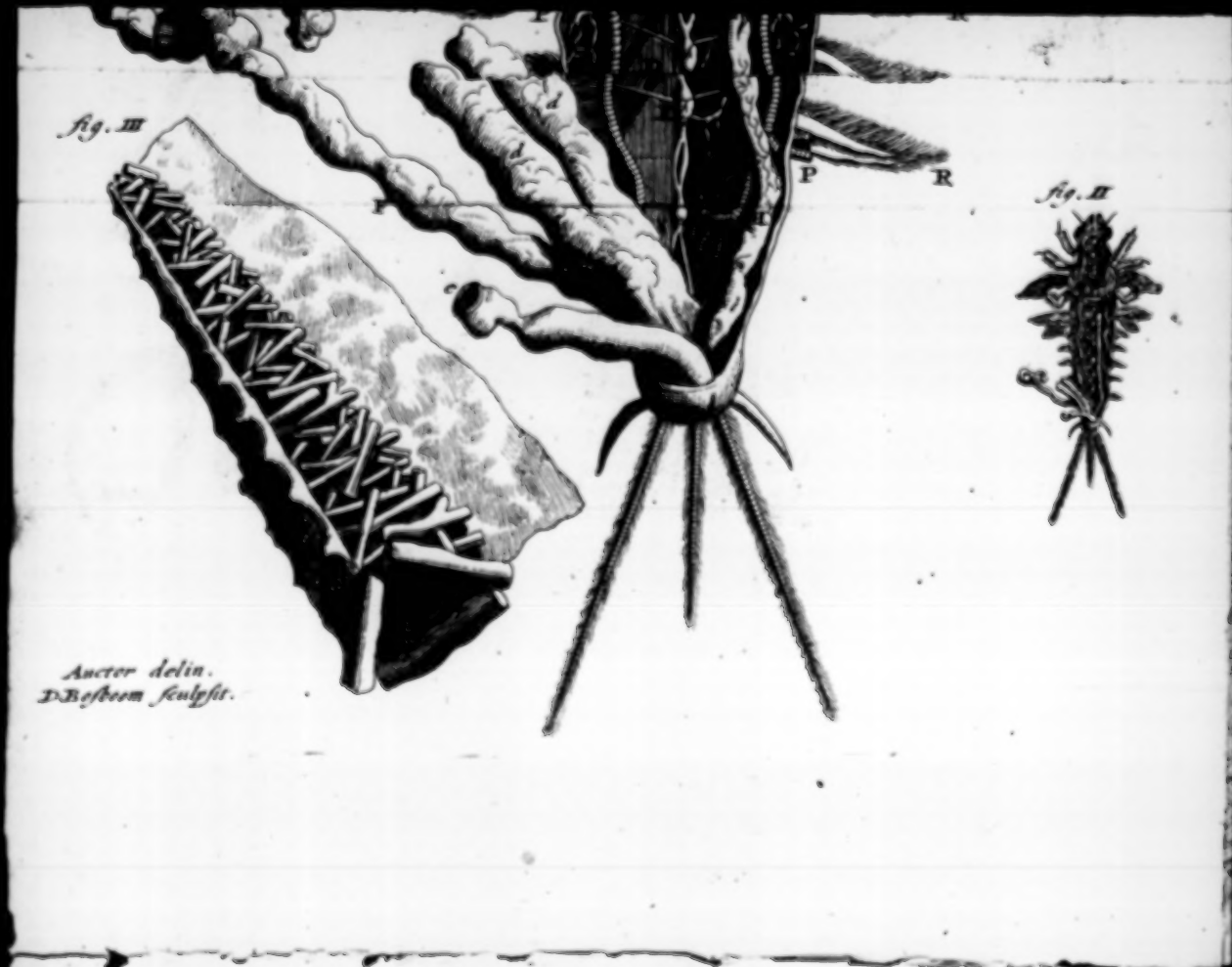
fig. III
fig. II
P
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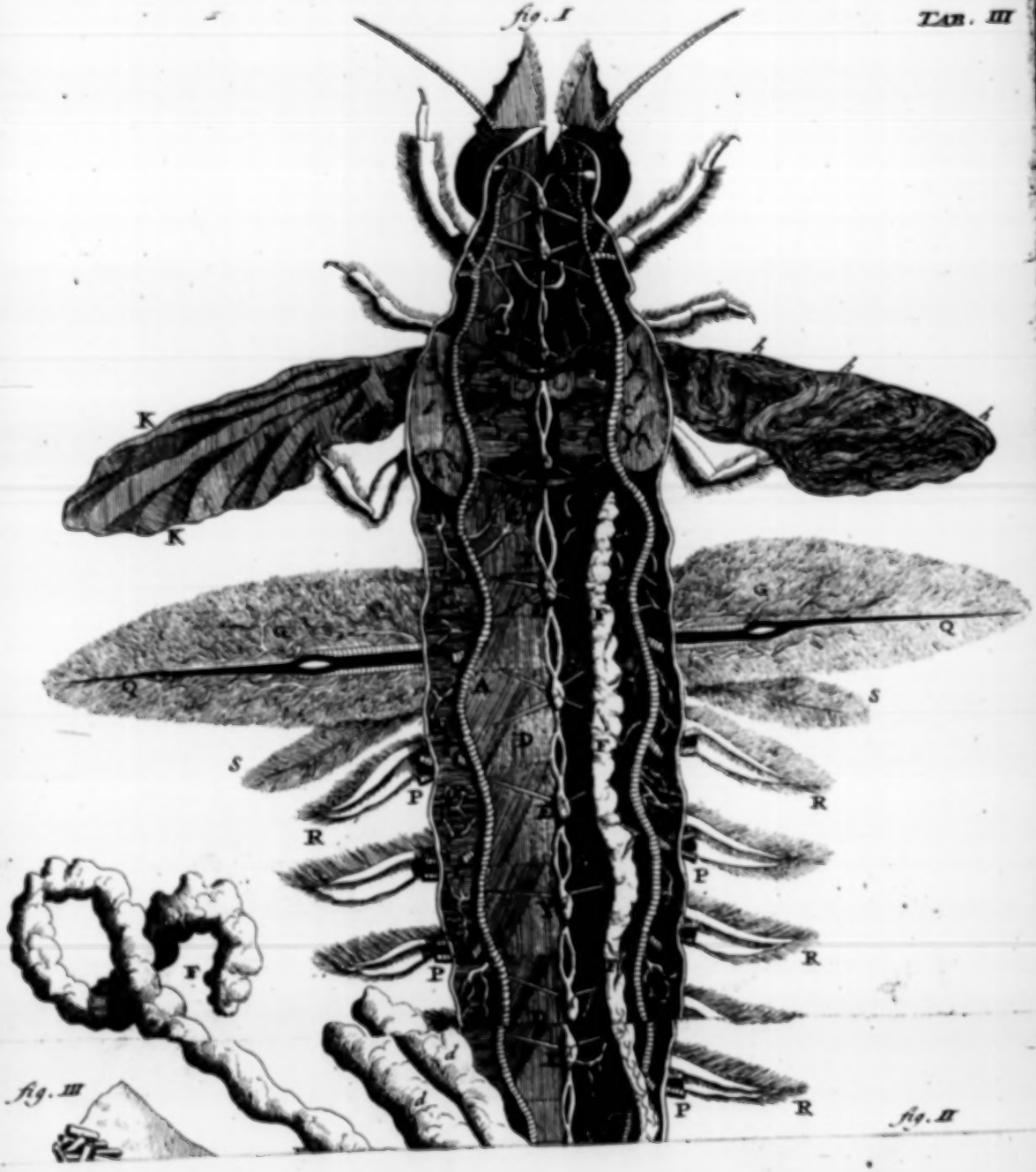
Auctor delin.
D. Bosboom sculpsit.

Tab. III



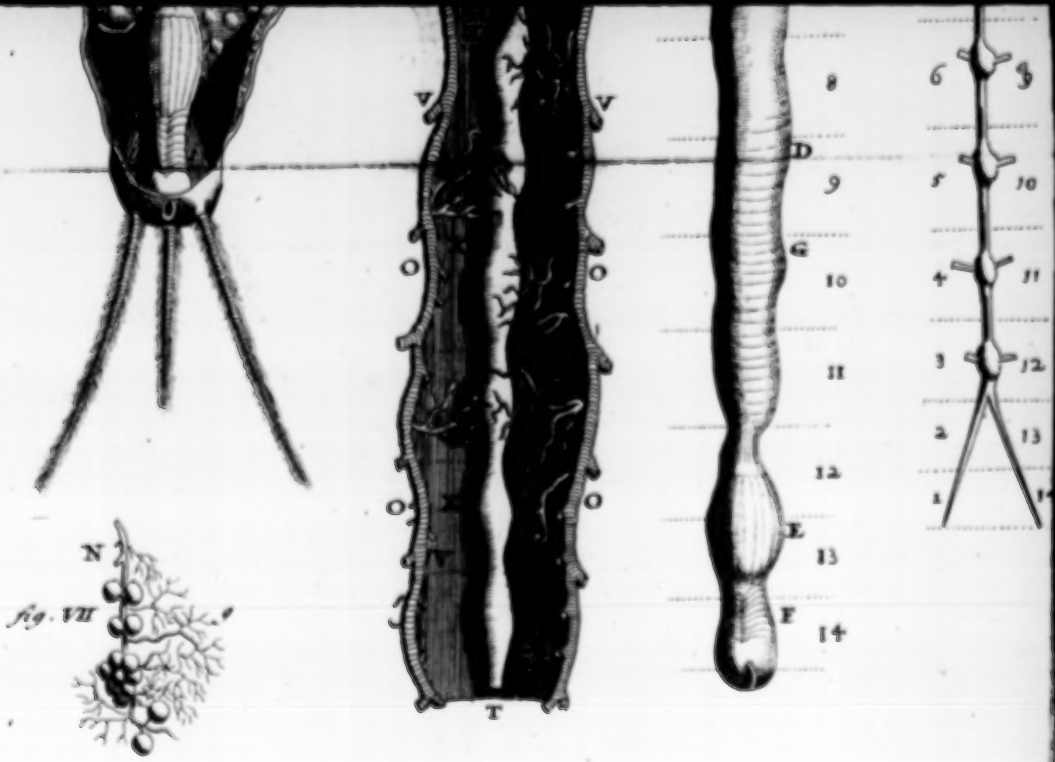

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fig. VII

TAB. IV

fig. I

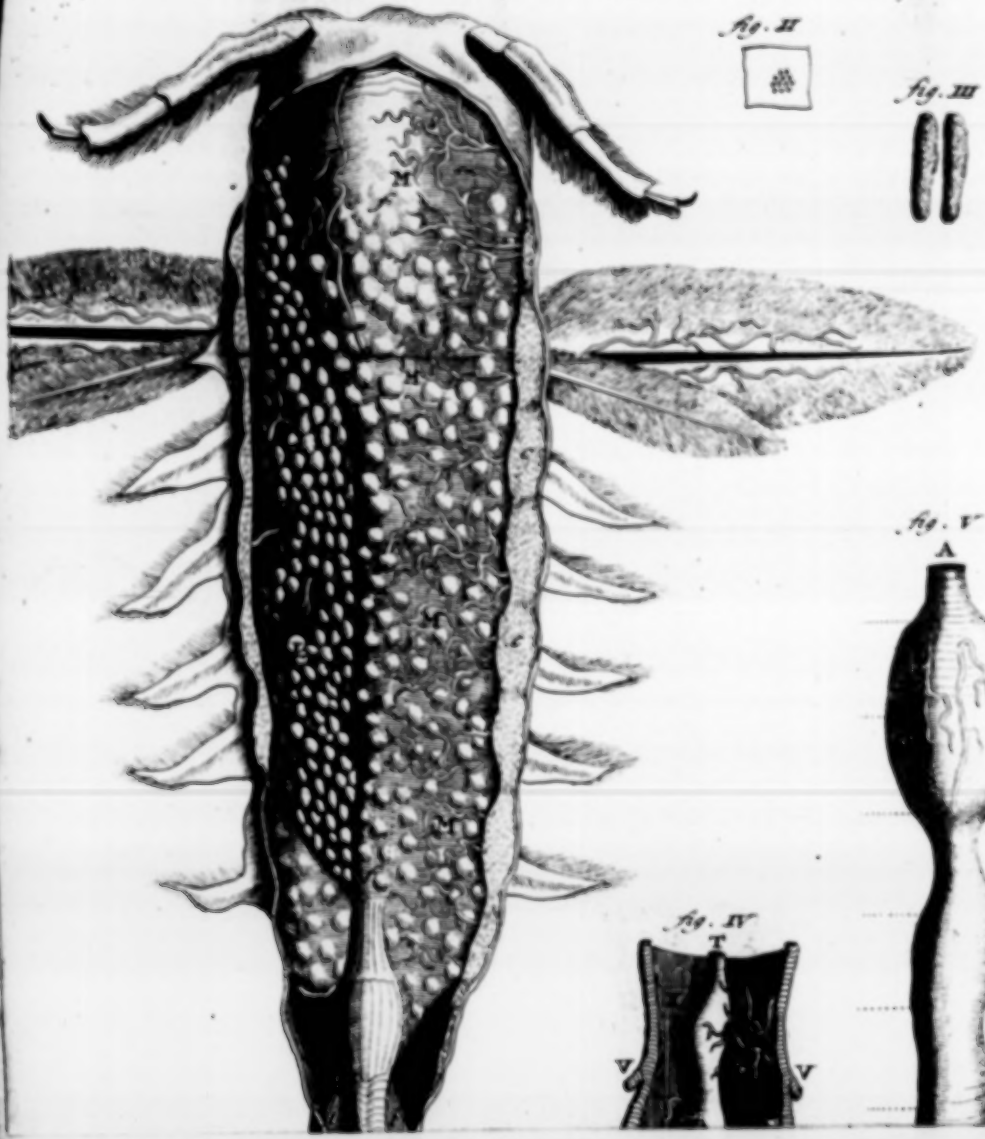


fig. II

fig. III

fig. IV

fig. V

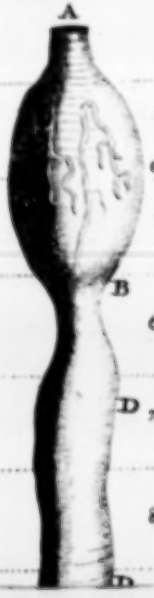
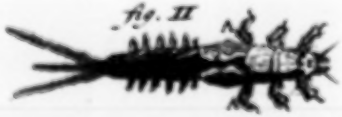


fig. VI

TAB. V

fig. I

fig. II



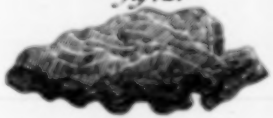
TAB. VI

fig. I

fig. II

fig. III

fig. IV



TAB. VII

Fig. I

Fig. II

TAB. VII

Fig. II

Fig. I